VOLUME 39 NUMBER 6 JUNE, 1955

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OF
OPHTHALMOLOGY

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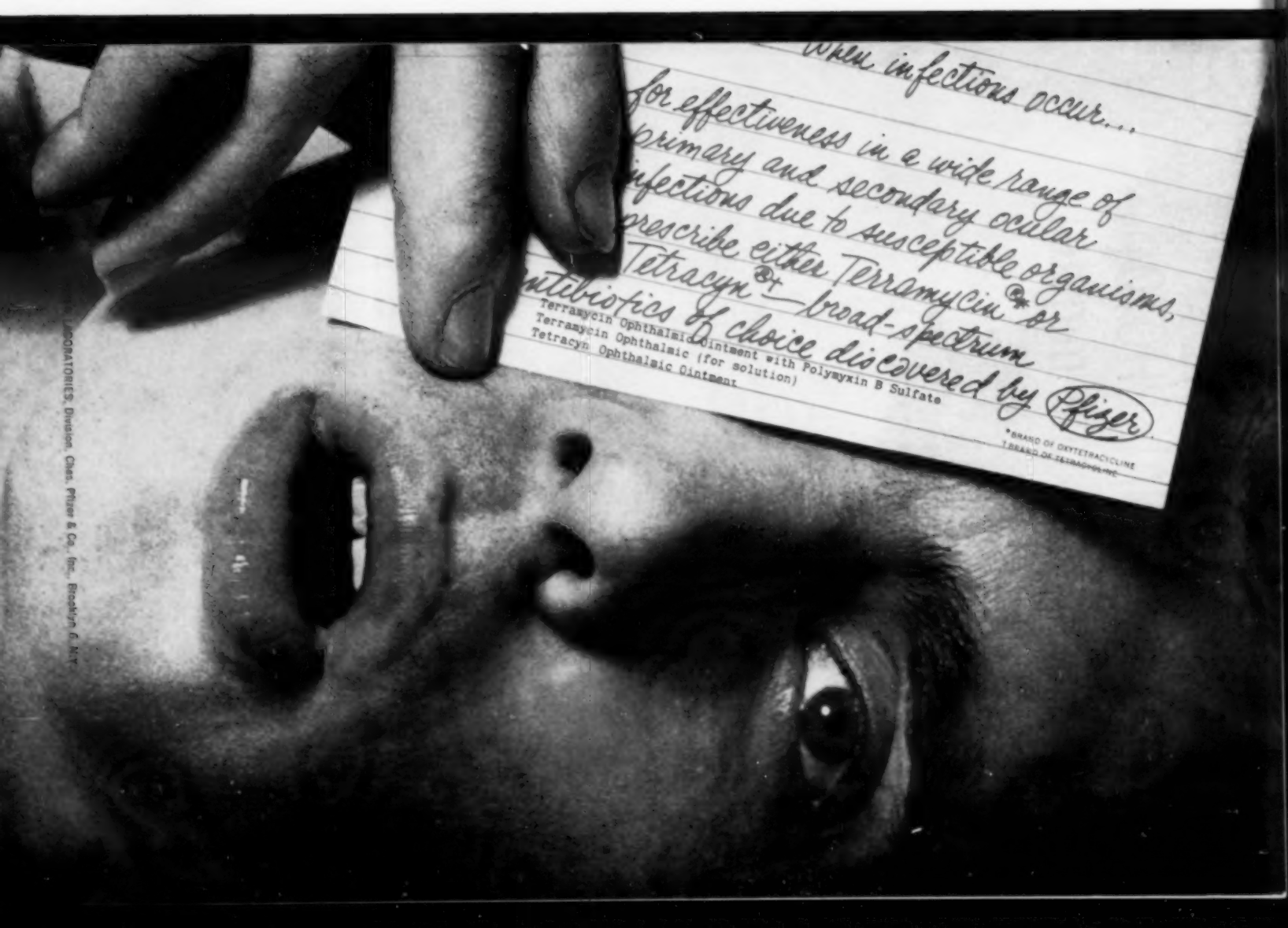
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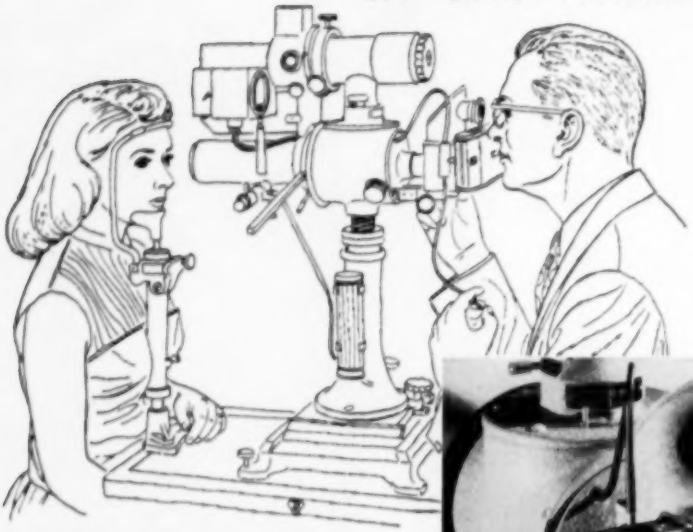

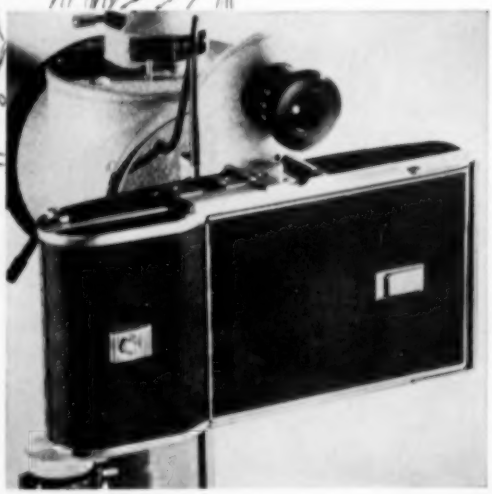

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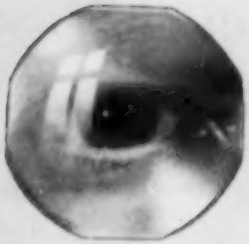

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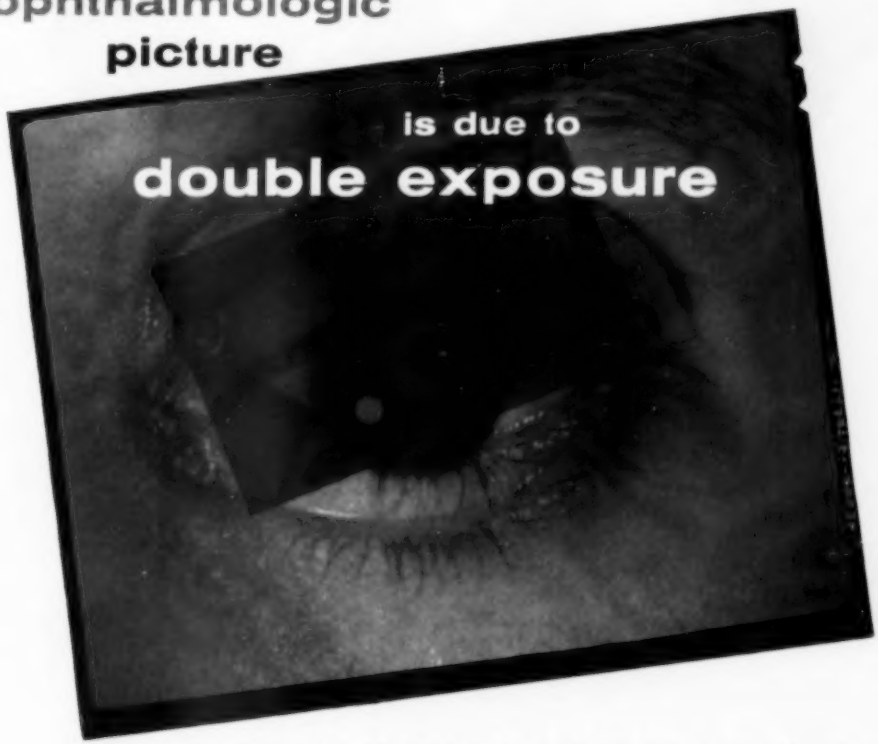

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1. Rukes, J. M., et al.: Metabolism 3:481, 1954. 2. Cannon, E. J., and Leopold, I. H.: A.M.A. Arch. Ophth. 47:426, 1952.

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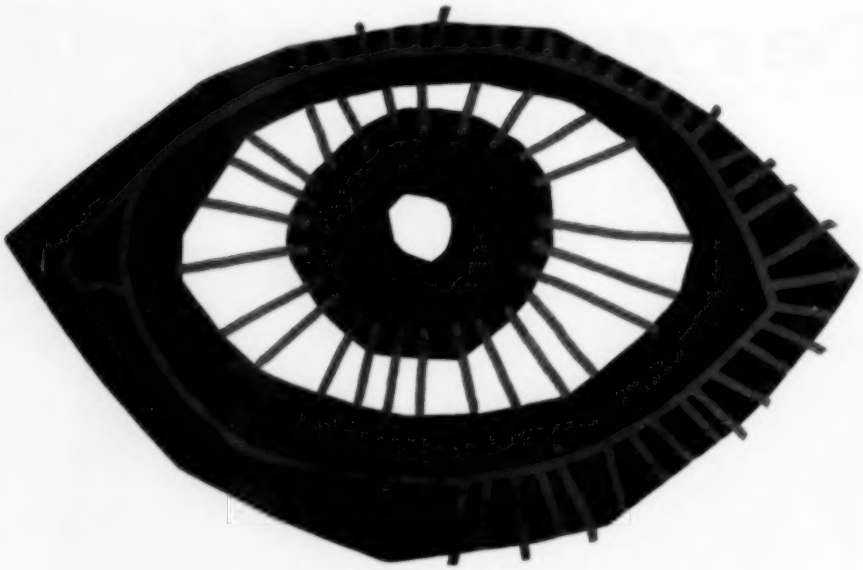

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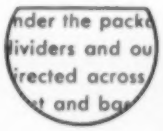

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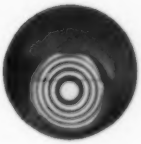

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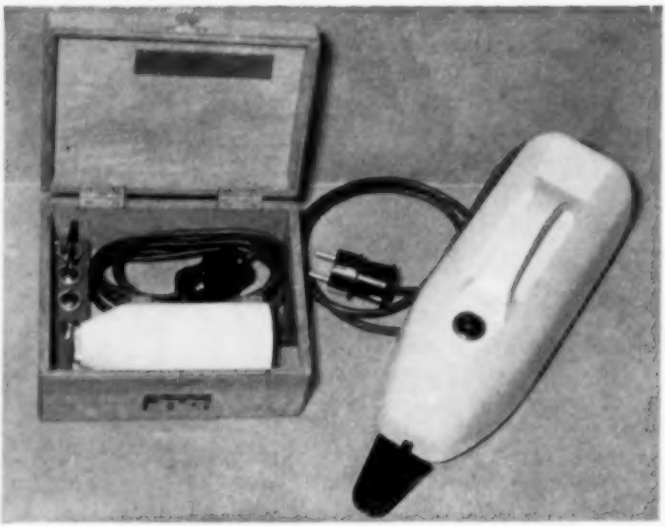

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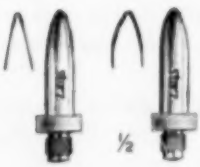

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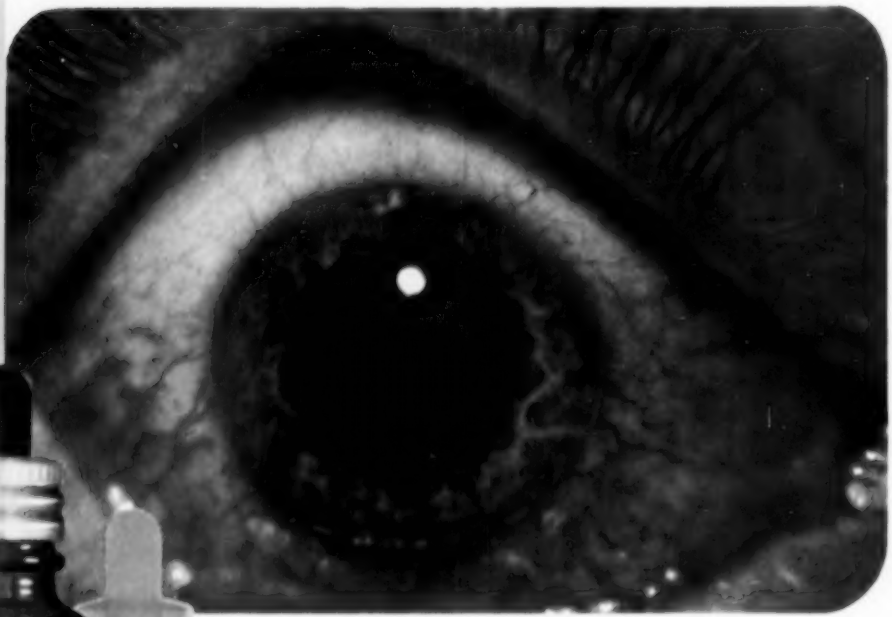

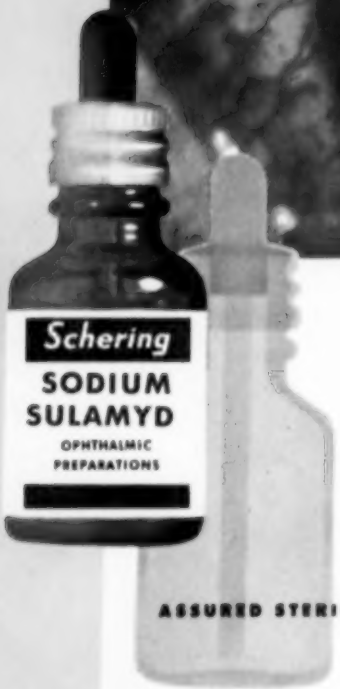

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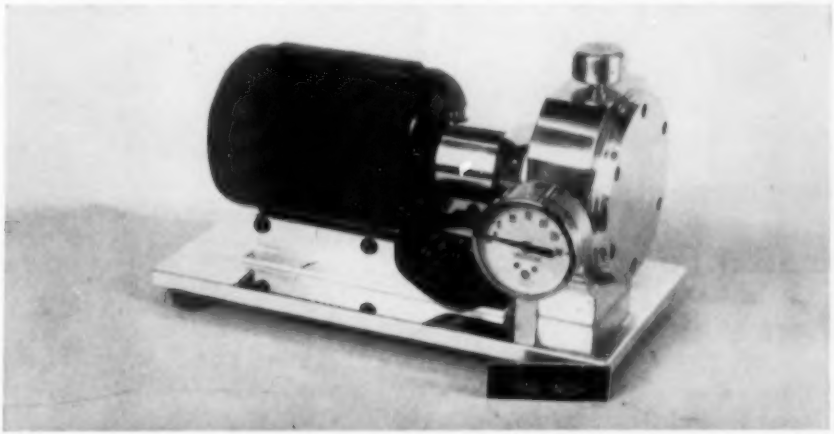

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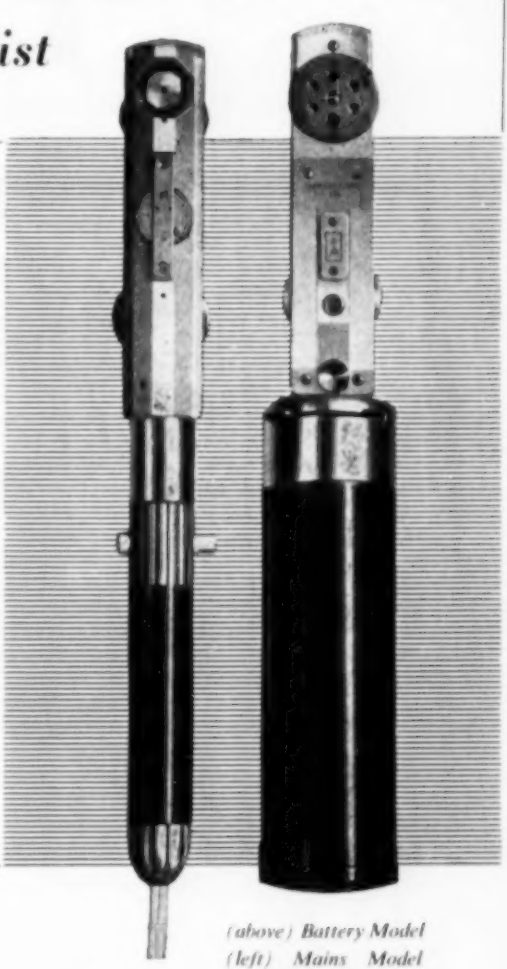

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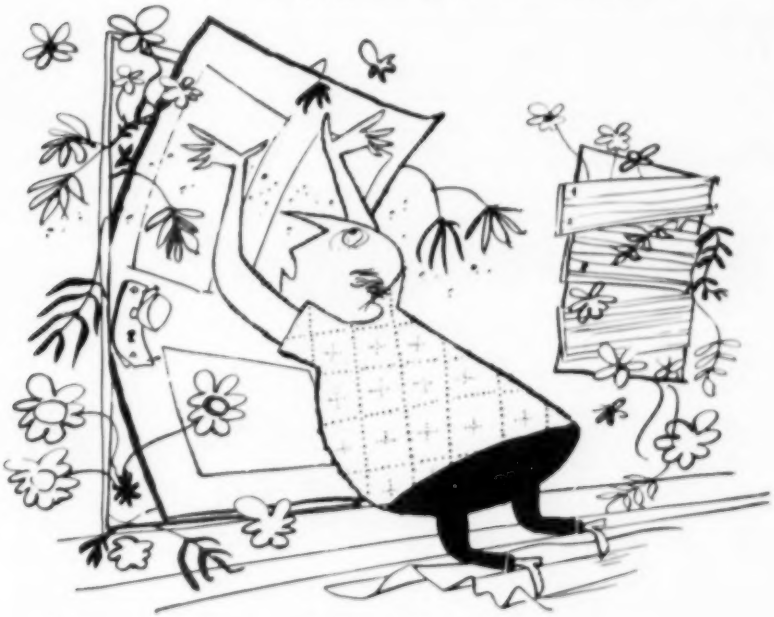

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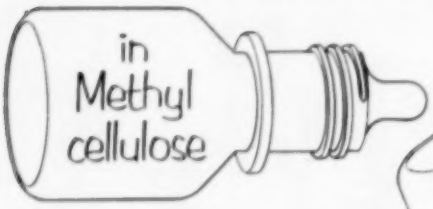

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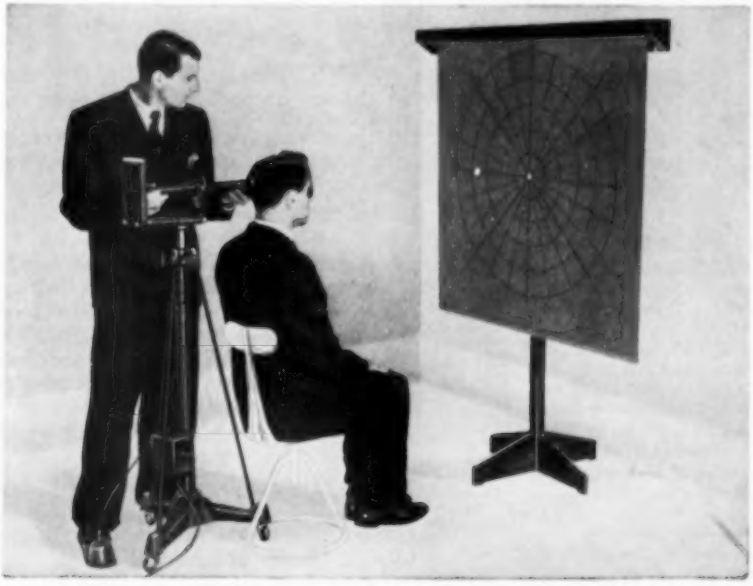

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* Am. J. Ophth. 36, 1130, 1953 Br. J. Ophth. 1939, 23, 239.

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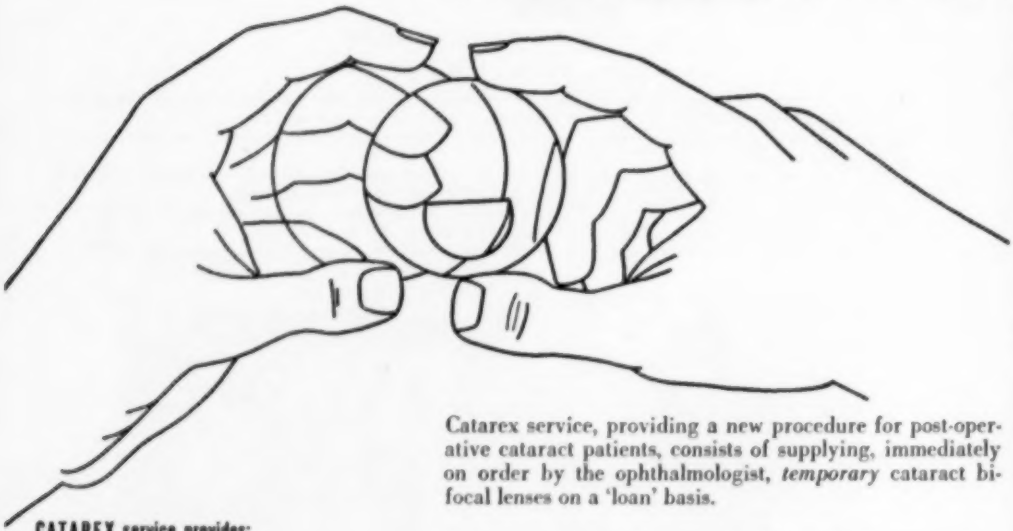

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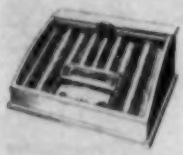

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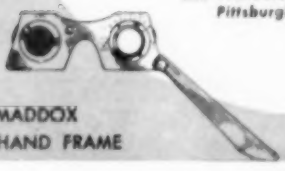

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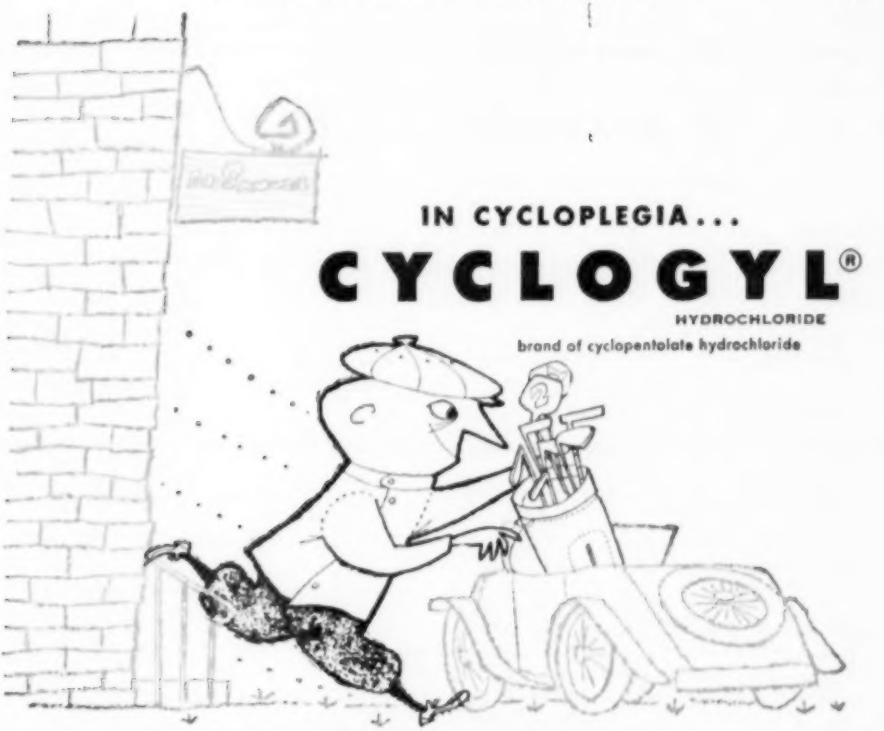

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1. Gordon, D. M., and Ehrenberg, M. H.: Am. J. Ophth. 38:831 (Dec.) 1954.

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5	12.5	2.67	15.0
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SERIES 3 · VOLUME 39 · NUMBER 6 · JUNE, 1955

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ABSTRACTS

General pathology, bacteriology, immunology; Vegetative physiology, biochemistry, pharmacology, toxicology; Physiologic optics, refraction, color vision; Diagnosis and therapy; Ocular motility; Conjunctiva, cornea, sclera; Uvea, sympathetic disease, aqueous; Glaucoma and ocular tension; Crystalline lens; Retina and vitreous; Optic nerve and chiasm; Neuro-ophthalmology; Eyeball, orbit, sinuses; Eyelids, lacrimal apparatus; Tumors; Injuries; Systemic disease and parasites; Congenital deformities, heredity; Hygiene, sociology, education and history 897

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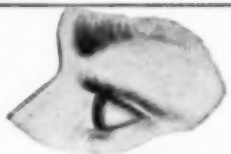

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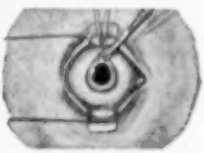

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VOLUME 39 JUNE, 1955 NUMBER 6

DIURNAL VARIATIONS OF SYSTEMIC VENOUS PRESSURE*

COMPARED WITH VARIATIONS OF TONOGRAPHIC READINGS AND OF BIOMICROSCOPIC ASPECT OF AQUEOUS VEINS

BRUNO BOLES-CARENINI,† M.D.
Bergamo, Italy

The numerous contributions attempting to elucidate the etiology of glaucoma which appear year after year in the ophthalmologic literature have been grouped under two main headings (Scheie[1]): The mechanical theory considers an obstacle to aqueous outflow to be responsible for the pressure increase of the glaucomatous eye while the neurovascular explanation stresses vascular instability, changes in capillary permeability, or functional changes in the facility of outflow of the intraocular fluid.

The mechanical aspect is supported by anatomic, gonioscopic, and tonographic evidence, although the exact location of the assumed obstacle is still controversial; different types of glaucoma may be considered due to occlusion of the chamber angle, the scleral trabeculum, the canal of Schlemm, its outlets, the scleral meshwork, and the aqueous veins.

From the neurovascular viewpoint, vascular instability may be responsible for local stasis and edema resulting in congestive glaucoma; for insufficient nutrition, resulting in optic nerve atrophy—chronic simple glaucoma; and, finally, the higher centers of vascular regulation may become responsible for a pressure increase in the efferent veins, resulting in higher back pressure and impediment to aqueous outflow. The latter possibility was considered by Ascher[2] shortly after the detection of the aqueous veins, when he discussed previous investigations supporting this hypothesis and their bearing on the compression phenomena in glaucomatous eyes.

The detection of the aqueous veins in 1941 gave new impetus to glaucoma research and numerous authors searched for possible changes in appearance and pressure of the episcleral vessels of normal and of glaucomatous eyes (Thomassen[3]; Löhlein[4]; Linnér, Rickenbach, and Werner[5]; Dobree[6]; Bain[7]).

Less numerous are the investigations concerning the relation between systemic venous pressure and intraocular pressure, some prior to the detection of the aqueous veins.

In 1932, Saint-Martin and Meriel,[8] studying systemic arterial pressure in glaucoma, determined the systemic venous pressure of some of their patients whose minimal arterial pressure could not be measured. They considered these data as a substitute for the minimal arterial pressure readings.

In 1936, Ciotola,[9] using the manometer of Claude, studied 37 persons with normal-pressure eyes and 31 suffering from primary glaucoma. He considered the systemic venous pressure of normal persons to be between 120 and 160 mm. H_2O; the systemic venous

* From the Department of Ophthalmology, College of Medicine, University of Cincinnati, Cincinnati, Ohio. This study was aided by United States Public Health Grant B-158.

† Assistant of the Clinica oculistica, Universita di Parma. Former research assistant, University Eye Clinic, Cincinnati.

pressure of 11 of the glaucomatous patients was found to be within the same range; 20 of the glaucomatous patients showed higher venous pressure readings, which, in some of these, was the only sign of abnormal vascular condition.

Two years later, Colomba,[10] by means of the manometer of Alestra and Ruffini, investigated the venous pressure of 14 glaucomatous patients, determined in the morning hours by single readings. In comparison to the assumed normal values of systemic venous pressure, between 70 and 115 mm. H_2O, the average systemic venous pressure readings of male glaucomatous patients (121 mm. H_2O) were higher than normal, and close to the maximal normal values in female patients (112 mm. H_2O).

Both Ciotola and Colomba examined recumbent subjects, but both restricted their study to single daily determinations, Ciotola without indicating the time of the day, whether the right or left arm, and which veins were used. Ochsner, Colp, Burch[11] and other authors stated that there are differences in systemic venous pressure, not only in connection with the "vascular distance" of the heart from the point of measurement, but also according to the particular vessel used, although vena cubitalis, vena cephalica, and vena basilica are close neighbors.

Evaluation of the results of both Ciotola and Colomba is made difficult by the fact that each author considers as normal a vastly different pressure range. Thus, were one to follow the normal figures of Colomba (70 to 115 mm. H_2O), not only the glaucomatous patients, but all those with normal intraocular pressure studied by Ciotola would have systemic venous pressure greatly in excess of normal (average values 156 mm. H_2O). On the other hand, following the normal figures of Ciotola (120 to 160 mm. H_2O) all the glaucomatous patients of Colomba would have average values (121 mm. H_2O) well within the limits of normal. We have to admit that present-day authors as well are not completely in agreement about the maximal and minimal limits of normal systemic venous pressure. For example, Best and Taylor[12] consider normal the systemic venous pressure value taken on the median cubital vein of the right arm of the recumbent patient if between 60 and 160 mm. H_2O, Wiggers[13] if between 50 and 140, Fulton[14] 40 to 100, Carpi[15] if about 110 to 120, and McLeod[16] about 70. Eyster and Middleton[18] believe that the systemic venous pressure should not exceed 100 mm. H_2O to be considered normal but admit that variations from a few cm. to 18 cm. H_2O are not uncommon.

As far as we know, priority may be accorded Ciotola and Colomba in dealing with this problem, but neither considered the diurnal variations of systemic venous pressure. Numerous investigators (Leaman, Jr.[17]; Eyster and Middleton[18]; Winsor and Burch[19]; and Hooker[20]) agree that the systemic venous pressure of normal persons shows different values at different times of day.

The first to study these diurnal variations in glaucomatous patients seems to have been Benstein[21] (1950). He used a simple "capillary" water manometer connected to a venipuncture needle and followed the systemic venous pressure of 50 patients with various types of glaucoma. Seven had systemic venous pressure values lower than 100 mm. H_2O, seven 100 and 120, seven between 120 and 150, 19 between 150 and 200, and 10 between 200 and 250 mm. H_2O. Nine patients showed no diurnal variations of systemic venous pressure; 12 an increase of systemic venous pressure toward the evening, and 29 an increase in the morning. The most common differences between maximum and minimum venous pressure readings were 20 to 30 mm. H_2O—seven times in patients with maximum in the evening and 12 times in patients with the maximum in the morning—although differences as high

as 80 to 100 mm. H_2O were also observed.

No control series of subjects with normal eye pressure is mentioned in the paper by Benstein who considers as normal the data reported by Waldman,[22] that is between 60 and 80 mm. H_2O with exceptional values of 40 to 50 and 100 to 120 mm. According to Waldman, almost all normal subjects showed, in the evening hours, increases of systemic venous pressure amounting to 10 to 30 mm. H_2O. Following Waldman's data, in 36 of Benstein's 50 glaucomatous patients the systemic venous pressure was above normal, sometimes excessively high; in 29 glaucoma patients the systemic venous pressure curve was inverted with highest values in the morning hours. Benstein reasons that if the systemic venous pressure is abnormally high, this must influence the pressure in the ocular veins and, therefore, interfere with the elimination of intraocular fluid.

Recently (1953) Weinstein and Forgacs[23] published a short paper on systemic venous pressure of normal and glaucomatous subjects, using Groak's technique on the cubital vein. With a single determination per patient, Weinstein and Forgacs were not able to confirm the results of Ciotola and of Benstein, whose glaucomatous patients showed values in excess of normal. However, with repeated systemic venous pressure determinations on each patient and by plotting diurnal curves, Weinstein and Forgacs obtained results paralleling those of Benstein, namely that the systemic venous pressure of normal persons was lower in the morning than in the evening hours, while in glaucomatous patients this rhythm was the reverse, showing the lowest values in the evening hours.

In the same publication, these authors reported on their study of experimentally provoked reactive hyperemia in capillaries of the finger; they found diurnal variations which, in their opinion, might also be present in the intraocular capillaries and, together with the diurnal variations of systemic venous pressure, might cause the diurnal changes of intraocular pressure.

The interesting conclusions by Weinstein and Forgacs, published at the time when our investigation started, increased our interest in this problem, the more because, in Weinstein and Forgacs' paper, the systemic venous pressure values are recorded only in two summarizing graphs without indicating when and how often the readings were taken; furthermore, the authors stated they could not confirm the conclusions of Ciotola and of Benstein who found an increase of systemic venous pressure in glaucomatous patients while Weinstein and Forgacs' graphs show definite differences in the average systemic venous pressure values of normal and of glaucomatous persons.

Personal Investigations

In the spring of 1953, when Dr. Ascher invited me to come to Cincinnati, he discussed plans for my fellowship with Professor Bietti and suggested that I should study the possible relations between systemic venous pressure and diurnal changes of intraocular pressure in aqueous veins and in tonographic readings of normal and of glaucomatous eyes. Thus, the purposes of my investigations were:

1. To ascertain whether there are statistically significant differences between the averages of systemic venous pressure values determined in normal and in glaucomatous persons at a certain hour of the day, for example 8:00 a.m.

2. Plotting the diurnal curves of the systemic venous pressure and comparing them with those of the intraocular pressure.

3. To study the appearance of aqueous veins at the times of day when the systemic venous pressure reached its highest and lowest values.

4. To calculate, for the same hours, the facility of aqueous outflow.

In this way I intended to find whether correlations between systemic venous pressure and intraocular pressure could be proved.

Method

My study comprised 20 persons with normal intraocular pressure and 30 glaucomatous patients, 19 suffering from chronic simple glaucoma and 11 suffering from congestive glaucoma. I classified as normal those subjects who, by accurate clinical examination (diurnal intraocular pressure curve for several days, repeated tonographic measurements, fundoscopic, gonioscopic, and campimetric examinations, and provocative tests) were determined to be definitely not glaucomatous. These persons showed no frank disease. Their ages were between 40 and 86 years; 14 were male and six female. For each of these persons, the diurnal curve of intraocular pressure was plotted using the Schiøtz tonometer at two-hour intervals between 8:00 a.m. and 10:00 p.m. with a few exceptions where the last reading was taken at 8:00 p.m. This was repeated for at least two subsequent days, in some cases for three or four days, until the times of the maxima and minima of eye pressure were clearly defined.

At the corresponding hours, the systemic venous pressure was measured on subsequent days with the direct manometer method to be described below. Additional venous pressure readings were taken at equal intervals prior to and after the hour of the highest and lowest diurnal eye pressure so that during an eight- to 10-hour period of the day, four venous pressure readings could be recorded. These four readings were made, on some subjects, during the same day, more often, however, on two consecutive days, using always the same vein and puncturing the same point if possible.

With the corneal microscope, the aqueous veins were studied and their appearance described at the hours corresponding to the highest and lowest systemic venous pressure. At these same hours I registered the facility of outflow with the electronic tonometer (Mueller), without a recording galvanometer. I followed exactly the rules developed during the last years for the use of this instrument as described by various authors and recently, from the Cincinnati Department of Ophthalmology, by Stepanik.[24] The lids were retracted with a light, nonmagnetic lid speculum. The readings were charted every 30 seconds for four minutes. The facility of outflow (c) was calculated according to the formula

$$c = \frac{V\Delta}{(Av\ P_t - P_o)\ t}$$

and the amount of aqueous formation (k) was ascertained by the formula

$$k = Po \times c$$

according to Grant,[25] in whose exhaustive papers the interpretation of these formulas and the significance of the method are discussed.

On the other hand, I should describe in detail the technique of measuring the systemic venous pressure, because even a small modification of the method may produce a marked difference in the results and may be the cause of the contradictions in the values reported by the authors mentioned above.

I used the so-called capillary water manometer as customary for measuring the pressure of the cerebrospinal fluid. It consists of a glass tube, 30-cm. long, with a 1.5-mm. bore, graduated in centimeters, subdivided into fifths of centimeters, and attached at a right angle by means of a three-way cock to a venipuncture needle (figs. 1 and 2).

Since the systemic venous pressure is influenced by muscular activity, the patient was examined in supine position with a small cushion under his head, after resting for 10 to 15 minutes, a time more than sufficient, according to Lyons, Kennedy, and Burwell,[26] to obtain constant systemic venous pressure readings. In order to prevent apprehension of the examinee which could influence the systemic venous pressure, every effort was made to eliminate excitement of the subjects who were previously told what

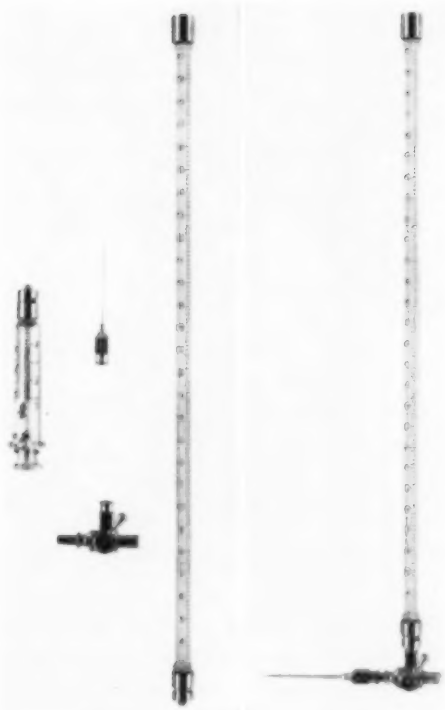

Fig. 1 Fig. 2

Figs. 1 and 2 (Boles-Carenini). (Fig. 1) Capillary water manometer with three-way cock, venipuncture needle (20-gauge), and two-cc. syringe. (Fig. 2) Capillary water manometer assembled with three-way cock and venipuncture needle.

to expect and why the examination was undertaken.

The right arm, abducted about 45 degrees and supported by a cushion, was fixed so that the elbow rested at the height of the junction of the anterior and middle third of the thoracic diameter that is supposed to correspond to the distance of the right heart from the table (Eyster,[27] 1929). A rubber hose was tightened around the upper arm for better visualization of the vena cubitalis. After washing the skin with 70-percent alcohol, a 20-gauge venipuncture needle mounted on a two-cc. syringe was introduced into the vena cubitalis in the direction of the blood flow. The rubber hose was loosened, the manometer, previously filled with sterile saline solution and attached to the three-way cock, was then connected with the venipuncture needle and the cock turned so as to permit free communication between vein and manometer.

By filling the glass tube and allowing the saline to enter the vein rather than allowing the blood to enter the glass manometer, coagulation of the blood inside the manometer is avoided and the resulting error excluded. The level of the saline column was then read and its correctness was checked by a repetition of the reading after a mild short compression of the arm above the point of introduction of the needle. An attempt was made to hold the manometer as perpendicularly as possible in order to avoid errors deriving from apparently higher readings which could result if the manometer were tilted.

Results and Discussion

a. Normotensive persons

In Tables 1 and 2 are reported the data of the diurnal changes of the intraocular pressure and systemic venous pressure in subjects with normal eyes; in Tables 3 and 4 are given the values of facility of outflow and production of aqueous, and the appearance and influx phenomena of the aqueous veins, studied at the time of the maximum and minimum systemic venous pressure.

From Table 1, it can be seen that some of these patients (2, 3, 4, and 5) showed diurnal variations greater than 5.0 to 6.0 mm. Hg, which some authors (Duke-Elder,[28] Magitot,[29] Adler,[30] and others considered to be the limit for normal diurnal excursions. Also, some of these subjects do not show the typical curve of intraocular pressure decreasing from the morning to the evening. But, considering the average diurnal curve of intraocular pressure (fig. 3) this gradual decrease is present (from 21.48 mm. Hg at 8:00 a.m. to 18.20 mm. Hg at 6:00 p.m.) and also the difference between maximum

TABLE 1

NORMAL EYES

DIURNAL CHANGES OF INTRAOCULAR PRESSURE

(mm. Hg, Schiøtz)

Subject No.	8 a.m.	10 a.m.	12 m.	2 p.m.	4 p.m.	6 p.m.	8 p.m.	10 p.m.
1	21.5	19.9	21.5	19.9	17.1	17.1	15.7	17.1
2	19.9	14.4	12.0	12.0	14.4	14.4	12.0	15.7
3	19.9	21.5	17.1	17.1	14.4	14.4	15.7	17.1
4	21.5	19.9	19.9	15.7	15.7	15.7	14.4	15.7
5	23.0	24.6	24.6	21.5	19.9	17.1	17.1	17.1
6	17.1	14.4	14.4	13.1	15.7	15.7	15.7	17.1
7	15.7	14.4	12.0	12.0	10.2	10.2	10.2	11.1
8	23.0	23.0	19.9	19.9	19.9	19.9	19.9	17.1
9	17.1	19.9	21.5	21.5	19.9	18.5	18.5	18.5
10	23.0	23.0	24.6	23.0	18.5	17.1	17.1	17.1
11	19.9	19.9	19.9	19.9	21.5	21.5	21.5	19.9
12	26.5	24.6	24.6	24.6	24.6	23.0	21.5	19.9
13	24.6	24.6	26.5	23.0	23.0	19.9	19.9	—
14	19.9	19.9	19.9	23.0	21.5	19.9	19.9	18.5
15	19.9	21.5	19.9	23.0	19.9	19.9	19.9	21.5
16	23.0	23.0	23.0	23.0	19.9	19.9	18.5	21.5
17	26.5	26.5	23.0	19.9	19.9	19.9	18.5	19.9
18	23.0	24.6	24.6	23.0	23.0	21.5	23.0	24.6
19	21.5	21.5	19.9	19.9	18.5	18.5	21.5	19.9
20	23.0	24.6	23.0	23.0	23.0	26.5	24.6	—
AVERAGE:	21.48	21.28	20.59	19.90	19.02	18.53	18.26	18.29

and minimum is well within the 5.0 to 6.0 mm. Hg limit (3.22).

From Table 2, we realize how difficult it is to define even approximately the normal limits of systemic venous pressure. The values of systemic venous pressure change throughout the day. At 8:00 to 9:00 a.m., most of the normal subjects presented readings between 70 and 120 mm. H_2O, while from 5:00 to 6:00 p.m. the range of values was between 110 and 160 mm. H_2O. Every normal subject studied presented a gradual increase of the systemic venous pressure values as the day progressed. This rise of systemic venous pressure varied from a minimum of 9.0 mm. H_2O (Case 13) to a maximum of 54 (Cases 6 and 7); in the average curve, it was 32.3 mm. H_2O from 99.8 mm. H_2O at 8:00 to 9:00 a.m. to 132 mm. H_2O at 5:00 to 6:00 p.m. This curve runs in a direction opposite to that of the intraocular pressure.

The highest intraocular pressure values of most of the normal subjects were found in the morning and decreased progressively throughout the day while, as described above, the systemic venous pressure showed the lowest values in the morning and proved to

TABLE 2

NORMAL EYES

DIURNAL CHANGES OF SYSTEMIC VENOUS PRESSURE

(cm. H_2O)

Subject No.	Observation No.			
	I	II	III	IV
1	10.8	12.0	13.4	15.8
2	11.6	13.2	13.4	14.4
3	9.2	9.4	10.4	13.2
4	8.6	9.8	10.4	12.2
5	12.4	11.8	15.2	17.1
6	7.8	9.0	12.6	13.2
7	7.4	7.8	12.0	12.8
8	13.2	13.4	14.4	14.8
9	11.2	12.2	13.6	13.2
10	11.6	12.4	13.2	14.2
11	17.2	17.8	18.6	18.3
12	11.9	12.6	12.2	14.6
13	13.9	14.1	12.9	14.8
14	8.2	9.6	10.2	11.4
15	7.2	9.4	12.2	12.4
16	7.2	9.0	9.2	9.8
17	8.2	10.0	11.2	11.8
18	6.5	7.0	8.8	9.2
19	5.2	5.8	6.8	7.0
20	10.2	10.6	13.2	13.8
AVERAGE:	9.98	10.84	12.18	13.20

TABLE 3

NORMAL EYES

TONOGRAPHIC READINGS CORRESPONDING TO MINIMUM AND MAXIMUM OF SYSTEMIC VENOUS PRESSURE

Subject No.	Minimum		Maximum	
	c	k	c	k
1	0.20	3.32	0.20	2.86
2	0.25	3.46	0.20	3.20
3	0.20	3.71	0.30	6.20
4	0.20	3.20	0.30	4.80
5	0.30	5.16	0.20	4.00
6	0.20	3.32	0.25	4.44
7	0.25	4.30	0.28	4.64
8	0.20	4.00	0.20	3.71
9	0.20	3.32	0.25	4.30
10	0.20	3.71	0.20	3.71
11	0.13	2.21	0.17	2.72
12	0.30	5.16	0.30	5.16
13	0.20	4.62	0.15	3.46
14	0.30	4.80	0.28	4.01
15	0.30	5.16	0.30	6.48
16	0.30	7.74	0.40	9.24
17	0.26	5.20	0.30	6.48
18	0.30	6.00	0.30	6.00
19	0.20	3.71	0.18	2.88
20	0.30	6.00	0.30	6.00
AVERAGE:	0.24	4.41	0.25	4.71

be increasing during the rest of the day. These observations are in accord with those of Waldman[22] and of Weinstein and Forgacs[23] referred to above. Consequently, in studying systemic venous pressure in different groups of subjects, for instance normal and glaucomatous, the investigator must determine and compare the systemic venous pressure at the same hours for the two groups

The data of Table 3, statistically evaluated with the t test of Student and also with the F test of Snedecor, indicate that no significant difference exists between the facility of outflow determined at the moment of minimum systemic venous pressure ($c = 0.24$) and that determined at the maximum of systemic venous pressure ($c = 0.25$); the same is true for k, amount of aqueous humor produced. Neither does Table 4 show remarkable differences between appearance and comportment of the aqueous veins studied at the moment of minimum and maximum systemic venous pressure. In fact, all the aqueous veins and recipient vessels showed the same appearance and the same influx phenomenon at the two observations, except in three cases: In Case 1 there was a change in the appearance of an aqueous vein; in Case 14, an aqueous vein was seen on the second observation which was not found on the first; and in Case 16, the influx phenomenon changed from blood influx to aqueous influx.

Considered as a whole, the data of these four tables give the impression that there is no direct relationship between systemic venous pressure and intraocular pressure of normal subjects.

b. PATIENTS WITH CHRONIC SIMPLE GLAUCOMA

In Tables 5, 6, 7, and 8 are reported the results of similar studies on 19 patients with chronic simple glaucoma. Without doubt, Table 6 is the most important, showing a quite different course of the systemic venous pressure. Twelve of the 19 glaucomatous subjects showed diurnal changes of systemic venous pressure exactly contrary to those observed on normal subjects and on the other seven patients of this group.

Cases 2, 6, 8, 10, 11, 12, 13, 14, 15, 17, 18, and 19 showed systemic venous pressure values highest in the morning and lowest in the evening with a gradual decrease parallel to that of the intraocular pressure.

So our glaucomatous patients may be grouped into two types: The first comprising seven of the 19 (about one third) characterized by systemic venous pressure with diurnal changes similar to those of the systemic venous pressure of normal subjects, lowest values in the morning, increasing during the day with a curve opposite to that of the intraocular pressure; the second group, comprising the other 12 subjects (about two thirds) in which the systemic venous pressure decreased from maximum values in the morning to minimum in the evening with a curve opposite in direction to that of the systemic venous pressure of normal subjects, but parallel to the diurnal curve of intraocular pressure.

TABLE 4

NORMAL EYES

AQUEOUS VEINS STUDY CORRESPONDING TO MINIMUM AND MAXIMUM OF SYSTEMIC VENOUS PRESSURE

Subject No.	Minimum			Maximum		
	Appearance of Aqueous Veins	Recipient Vessel	Influx Phenomenon	Appearance of Aqueous Veins	Recipient Vessel	Influx Phenomenon
1	Pink	Stratified	Aqueous	Clear	Stratified	Aqueous
2	Clear	Stratified	Blood	Clear	Stratified	Blood
3	Stratified	Stratified	Aqueous	Clear	Stratified	Aqueous
4	Clear	Stratified	Aqueous	Clear	Stratified	Aqueous
5	Pink	Pink	Blood	Pink	Pink	Blood
6	Pink, clear	Stratified	Blood	Pink, clear	Stratified	Blood
7	Pink	Stratified	Blood	Pink	Stratified	Blood
8	Clear	Stratified	Blood	Clear	Stratified	Blood
9	Clear	Stratified	Aqueous	Clear	Stratified	Aqueous
10	Clear	Pink	Blood	Clear	Pink	Blood
11	Clear	Stratified	Blood	Clear	Stratified	Blood
12	Clear	Stratified	Blood	Clear	Stratified	Blood
13	Clear	Stratified	Blood	Clear	Pink	Blood
14	No large aqueous vein found		—	Clear	Stratified	Blood
15	Clear	Pink	Aqueous	Clear	Pink	Aqueous
16	Clear	Stratified	Blood	Clear	Stratified	Aqueous
17	No large aqueous vein found		—	No large aqueous vein found		—
18	No large aqueous vein found		—	No large aqueous vein found		—
19	Pink	Stratified	Aqueous	Clear	Stratified	Aqueous
20	Clear	Stratified	Aqueous	Clear	Stratified	Aqueous

TABLE 5

CHRONIC SIMPLE GLAUCOMA

DIURNAL CHANGES OF INTRAOCULAR PRESSURE

(mm. Hg, Schiøtz)

Patient No.	8 a.m.	10 a.m.	12 m.	2 p.m.	4 p.m.	6 p.m.	8 p.m.	10 p.m.
1	34.7	32.3	28.3	28.3	28.3	24.6	23.0	23.0
2*	34.7	34.7	32.3	28.3	28.3	26.5	21.3	19.9
3	32.3	30.3	37.2	37.2	37.2	34.7	23.0	26.5
4	26.5	28.3	28.3	26.5	28.3	24.6	24.6	23.0
5	28.3	24.6	24.6	30.3	28.3	24.6	23.0	21.5
6*	24.6	30.3	30.3	24.6	23.0	23.0	19.9	19.9
7	28.3	30.3	28.3	28.3	26.5	26.5	23.0	21.5
8*	23.0	30.3	30.3	30.3	28.3	24.6	19.9	19.9
9	28.3	30.3	30.3	26.5	26.5	26.5	24.6	24.6
10*	34.7	30.3	34.7	34.7	34.7	34.7	32.3	34.7
11*	34.7	34.7	32.3	23.0	19.9	26.5	23.0	23.0
12*	30.3	30.3	28.3	24.6	21.3	21.3	19.9	19.9
13*	34.7	30.3	30.3	28.3	24.6	24.6	23.0	—
14*	30.3	30.3	26.5	26.5	24.6	26.5	26.5	26.5
15*	32.3	37.4	30.3	23.0	24.6	26.5	26.5	26.5
16	37.2	34.7	37.2	30.3	28.3	30.3	28.3	32.3
17*	37.2	37.2	34.7	32.3	32.3	28.3	26.5	—
18*	30.3	32.3	32.3	34.7	32.3	30.3	26.5	—
19*	30.3	26.5	26.5	26.5	24.6	28.3	28.3	—
AVERAGE:	31.19	31.35	30.68	28.64	27.47	26.99	24.37	24.18
* Average of group with systemic venous pressure decreasing during the day	31.42	32.02	30.73	28.07	26.54	26.76	27.47	23.79
Average of group with systemic venous pressure increasing during the day	30.80	30.11	30.60	29.63	29.06	27.40	24.21	24.57

TABLE 6

CHRONIC SIMPLE GLAUCOMA

DIURNAL CHANGES OF SYSTEMIC VENOUS PRESSURE

(cm. H_2O)

Patient No.	Observation No.			
	I	II	III	IV
1	7.2	8.0	8.6	9.4
2*	17.4	19.0	15.3	14.8
3	17.8	18.6	19.6	19.4
4	17.2	17.8	18.6	18.4
5	14.2	14.4	15.0	16.4
6*	11.4	11.6	10.2	9.0
7	12.6	12.8	12.8	13.4
8*	14.2	14.0	12.6	10.8
9	11.8	12.4	12.2	13.4
10*	8.0	9.6	10.0	7.8
11*	12.2	9.8	9.6	9.2
12*	14.8	13.2	13.8	12.4
13*	13.6	13.2	12.4	11.4
14*	15.2	15.0	13.8	13.4
15*	10.2	9.4	8.8	7.2
16	10.6	11.0	13.0	13.4
17*	16.0	16.2	15.4	13.0
18*	15.4	15.0	14.6	14.2
19*	17.2	16.4	15.2	14.8
AVERAGE:	13.53	13.49	13.23	12.72
* Average of group with systemic venous pressure decreasing during day	13.80	13.53	12.64	11.50
Average of group with systemic venous pressure increasing during day	13.06	13.57	14.26	14.83

This is in accord with Benstein's observations, the only difference being that, besides patients with increasing or decreasing systemic venous pressure, Benstein also found some with no diurnal changes of systemic venous pressure. Benstein's percentage of glaucomatous patients with systemic venous pressure decreasing throughout the day, being equal to 58 percent, is close to my findings.

Having found that all glaucomatous patients belong in either of these two groups, we now shall consider the other tables of this series:

At the foot of Table 5 are reported the average curves of intraocular pressure of the two groups and the average curve of all the patients together. The three curves having absolute values slightly different show, however, rather similar drops. This means that in the two groups, the intraocular pressure showed diurnal changes in the same sense.

In Table 6, however, the two groups show two average curves of systemic venous pressure running in opposite directions, one increasing, the other decreasing through the day. The average curve of all the patients together results in a decreasing curve. As Benstein found, the variations are in the range of 20 to 30 mm. H_2O with a minimum of 8.0 mm. H_2O and a maximum of 34 mm. H_2O. Both groups showed at the first determination (8:00 to 9:00 a.m.), average values higher than those of the normotensive group; this difference proved to be significant on statistical evaluation with the t test of Student.

This means that, contrary to Weinstein's and Forgacs' assertion, and in accord with the findings of Ciotola and of Benstein, it can be found, also with a single determination in the morning, that glaucomatous patients have a systemic venous pressure significantly higher than normal subjects.

Table 7 shows that the facility of outflow is greater when the systemic venous pressure is at its minimum and lower when the systemic venous pressure is at its maximum: The differences are very small and statistically not significant on the t and F tests, 0.20 against 0.19 for all of the patients; 0.22 against 0.19 for the group with systemic venous pressure decreasing during the day. There is no difference (0.18 against 0.18) for the group with systemic venous pressure increasing during the day. Also the differences found for k, amount of aqueous production, were not significant. It is possible, however, that in a larger series of cases these differences might prove to be significant, at least for the group with systemic venous pressure decreasing where they were not too far from being statistically significant.

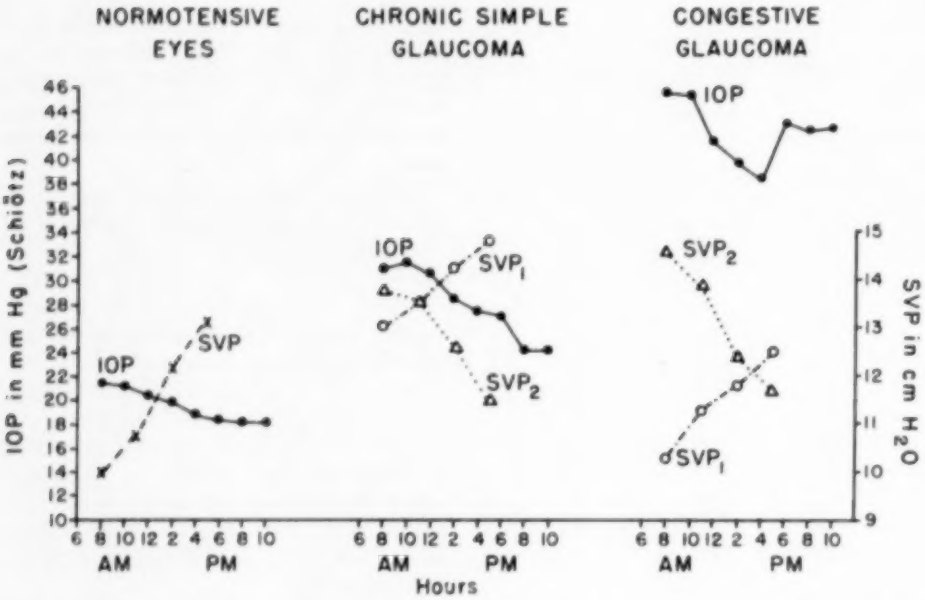

Fig. 3 (Boles-Carenini). In patients with normotensive eyes and in some glaucomatous patients systemic venous pressure increases through the day. In more than half of glaucomatous patients, systemic venous pressure drops through the day showing a course parallel to that of intraocular pressure. The aqueous veins of about half of the glaucomatous eyes showed increased blood content corresponding to the peak of systemic venous pressure. All aqueous veins were clear at the time of lowest systemic venous pressure.

Very interesting also are the observations reported in Table 8, relative to the aqueous veins studies. Nine subjects showed variations of the aqueous vein appearance (Cases 11, 14, and 18), changes of the aqueous influx phenomenon (Cases 1, 4, 6, 8, 10, and 17), or both (Case 1), when observed at the moment of maximum or at the moment of minimum systemic venous pressure. Of these nine subjects, seven belonged to the group with systemic venous pressure decreasing and two to the group with systemic venous pressure increasing throughout the day.

Most important is that these changes were always in the same sense, that is, always from aqueous influx phenomenon (when the systemic venous pressure was at the minimum) to blood influx phenomenon (when the systemic venous pressure was at the maximum), or from the appearance of a clear, transparent aqueous vein to an aqueous vein pink, red, or stratified. It seems that the changes in the systemic venous pressure might influence the appearance and dynamics of the episcleral vessels and aqueous veins.

Considered as a whole the data of these four tables concerning patients with chronic simple glaucoma give the impression that, at least in some of these patients, there is a direct influence of systemic venous pressure on the intraocular pressure and the aqueous veins.

c. Patients with congestive glaucoma

From Tables 9, 10, 11, and 12 relative to 11 patients with congestive glaucoma similar deductions may be derived. Here, also, we can distinguish two groups of patients, one with systemic venous pressure increasing throughout the day (four of 11) and one

TABLE 7

CHRONIC SIMPLE GLAUCOMA

TONOGRAPHIC READINGS CORRESPONDING TO MINIMUM AND MAXIMUM OF SYSTEMIC VENOUS PRESSURE

Patient No.	Minimum		Maximum	
	c	k	c	k
1	0.15	4.62	0.15	3.78
2*	0.25	5.40	0.30	8.88
3	0.20	6.95	0.15	4.84
4	0.05	1.00	0.05	1.08
5	0.30	6.00	0.30	5.57
6*	0.15	2.78	0.20	3.86
7	0.26	7.89	0.30	8.52
8*	0.15	3.78	0.15	3.46
9	0.15	3.94	0.17	4.28
10*	0.20	5.68	0.20	5.46
11*	0.30	6.48	0.20	5.64
12*	0.22	4.18	0.20	5.05
13*	0.25	5.25	0.20	5.40
14*	0.30	6.93	0.20	5.04
15*	0.30	6.93	0.15	3.78
16	0.10	2.73	0.15	3.46
17*	0.20	4.84	0.15	4.84
18*	0.12	3.55	0.15	4.09
19*	0.22	4.40	0.20	5.46
AVERAGE:	0.20	4.91	0.19	4.87
* Average of group with systemic venous pressure decreasing during day	0.22	5.02	0.19	5.08
Average of group with systemic venous pressure increasing during day	0.18	4.73	0.18	4.50

with systemic venous pressure decreasing (seven of 11); the variations between minimum and maximum values of systemic venous pressure were again in the range from 20 to 30 mm. H_2O with a maximum of 40 mm. H_2O and a minimum of 14 mm. H_2O. The direction of the curve of intraocular pressure was the same for the two groups; outflow facility and amount of aqueous humor production did not change if studied at the moment of highest and lowest systemic venous pressure.

A different appearance of the aqueous veins was found in five patients (Cases 4, 5, 6, 7, and 10) when observed at the moment of minimum and maximum systemic venous pressure; only one case (10) showed change from aqueous to blood influx phenomenon. Also in these cases, the variations in the appearance of the aqueous veins were always the same: clear aqueous vein when systemic venous pressure was low; pink, red, or stratified aqueous vein when the systemic venous pressure was high.

Therefore what we previously stated with regard to patients with chronic simple glaucoma must be repeated for some of the patients with congestive glaucoma, that is, there seems to be a direct influence of systemic venous pressure on intraocular pressure and on aqueous veins.

COMMENT

The interpretation of these results does not seem to be easy. The systemic venous pressure in glaucomatous patients was found to be higher than in normal subjects and showed, in 18 of 30 glaucomatous patients, a rhythm opposite to the diurnal variations of normotensive persons. These facts could well support the theory which attributes remarkable importance to the cardiovascular system as a factor in the etiology of intraocular hypertension. Not all authors fully agree about this theory because a relation between cardiovascular changes and ocular hypertension has never been exactly established and because the contributions are often contradictory; recently Sugar[31] observed that 63 percent of a series of patients with chronic simple glaucoma had associated hypertensive vascular disease and vascular sclerosis, but Sunde,[32] in the same year (1950), found the incidence of cardiovascular disease to be the same, comparing 100 patients with simple glaucoma to 100 controls.

In my patients not only the systemic venous pressure was studied but also the arterial blood pressure and the condition of the cardiovascular system using the advice of a consultant internist. Comparing the findings of the normal series with those of the glaucomatous series, we did not find a greater incidence of the cardiovascular disease in any group, the only difference being in the comportment

TABLE 8

CHRONIC SIMPLE GLAUCOMA

AQUEOUS VEINS STUDY CORRESPONDING TO MINIMUM AND MAXIMUM OF SYSTEMIC VENOUS PRESSURE

Patient No.	Minimum			Maximum		
	Appearance of		Influx Phenomenon	Appearance of		Influx Phenomenon
	Aqueous Veins	Recipient Vessel		Aqueous Vein	Recipient Vessel	
1	Clear	Stratified	Aqueous	All red		—
2	Clear	Stratified	Blood	Clear	Stratified	Blood
3	Clear	Stratified	Blood	Clear	Stratified	Blood
4	Clear	Stratified	Aqueous	Clear	Stratified	Blood
5	Clear	Stratified	Aqueous	Clear	Clear	Aqueous
6	Clear	Stratified	Aqueous	Clear	Pink	Stasis
7	Clear	Stratified	Blood	Clear	Stratified	Blood
8	Clear	Stratified	Aqueous	Clear	Stratified	Blood
9	Clear	Stratified	Blood	Clear	Stratified	Blood
10	Clear	Stratified	Aqueous	Clear	Stratified	Blood
11	Clear, clear	Almost clear	Aqueous	Pink, stratified	Red	Aqueous
12	Clear	Stratified	Aqueous	Clear	Stratified	Aqueous
13	Clear	Stratified	Aqueous	Clear	Stratified	Aqueous
14	Clear	Stratified	Aqueous	Pink	Pink	Aqueous
15	No large aqueous vein found		—	No large aqueous vein found		—
16	No large aqueous vein found		—	No large aqueous vein found		—
17	Clear	Stratified	Aqueous	Clear	Stratified	Blood
18	Clear	Stratified	Blood	Clear	Pink	Blood
19	No large aqueous vein found		—	No large aqueous vein found		—

TABLE 9

CONGESTIVE GLAUCOMA

DIURNAL CHANGES OF INTRAOCULAR PRESSURE

(mm. Hg, Schiøtz)

Patient No.	8 a.m.	10 a.m.	12 m.	2 p.m.	4 p.m.	6 p.m.	8 p.m.	10 p.m.
1*	40.0	34.7	34.7	34.7	32.3	40.0	37.2	37.2
2	46.0	40.0	34.7	40.0	40.0	40.0	32.3	34.7
3	62.9	62.9	51.6	37.2	58.9	62.9	58.9	62.9
4*	40.0	37.2	49.5	34.7	34.7	46.0	46.0	42.9
5	28.3	26.5	37.2	40.0	34.7	34.7	32.3	32.9
6*	53.3	53.3	53.3	53.3	40.0	34.7	34.7	40.0
7*	62.9	62.9	48.3	48.3	55.1	62.9	62.9	48.3
8	34.7	46.0	40.0	32.3	34.7	46.0	46.0	40.0
9	53.3	42.9	40.0	30.3	26.5	26.5	34.7	40.0
10*	37.2	53.3	46.0	42.9	32.3	37.2	40.0	46.0
11*	42.9	40.0	40.0	42.9	34.7	40.0	40.0	—
AVERAGE:	45.59	45.43	41.57	39.69	38.54	42.81	42.27	42.49
* Average of group with systemic venous pressure decreasing during the day	46.05	46.90	45.30	42.80	38.18	43.46	43.47	42.88
Average of group with systemic venous pressure increasing during the day	45.04	43.66	0.70	35.96	38.96	42.02	40.84	42.10

TABLE 10

CONGESTIVE GLAUCOMA

DIURNAL CHANGES OF SYSTEMIC VENOUS PRESSURE
(cm. H_2O)

Patient No.	Observation No.			
	I	II	III	IV
1*	7.2	5.2	4.6	4.2
2	11.2	12.2	12.6	13.2
3	8.8	9.4	10.2	11.2
4*	10.2	7.9	6.4	6.2
5	12.2	12.8	13.4	13.6
6*	18.8	17.6	16.8	16.2
7*	18.0	18.6	17.4	16.6
8	6.4	7.8	9.0	9.8
9	12.8	14.2	14.0	14.8
10*	16.8	18.2	14.6	14.0
11*	16.5	16.0	14.4	13.2
AVERAGE:	12.62	12.72	12.12	12.09
* Average of group with systemic venous pressure decreasing during day	14.58	13.92	12.37	11.73
Average of group with systemic venous pressure increasing during day	10.28	11.28	11.84	12.52

TABLE 11

CONGESTIVE GLAUCOMA

TONOGRAPHIC READINGS CORRESPONDING TO MINIMUM AND MAXIMUM OF SYSTEMIC VENOUS PRESSURE

Patient No.	Minimum		Maximum	
	c	k	c	k
1*	0.08	2.78	0.10	3.47
2	0.25	6.83	0.25	6.06
3	0.10	3.08	0.10	2.73
4*	0.15	4.09	0.10	2.67
5	0.10	2.79	0.08	2.40
6*	0.07	3.16	0.07	3.05
7*	— not done —		— not done—	
8	0.05	1.81	0.05	4.64
9	0.15	4.84	0.10	3.23
10*	0.05	2.18	0.05	1.50
11*	0.07	2.26	0.05	1.94
AVERAGE:	0.11	3.38	0.09	3.17
* Average of group with systemic venous pressure decreasing during day	0.08	2.89	0.07	2.53
Average of group with systemic venous pressure increasing during day	0.12	3.87	0.11	3.81

of the systemic venous pressure.

According to recent belief, the venous and the arterial systems are in some way independent of each other with no direct rapport between systemic venous pressure and arterial blood pressure.

Proof of this is the fact that the small peripheral vessels, increasing in tone, cause an increase of the arterial blood pressure and, at the same time, a drop in the systemic venous pressure, because of the decreased

TABLE 12

CONGESTIVE GLAUCOMA

AQUEOUS VEINS STUDY CORRESPONDING TO MINIMUM AND MAXIMUM OF SYSTEMIC VENOUS PRESSURE

Patient No.	Minimum			Maximum		
	Appearance of Aqueous Vein	Recipient Vessel	Influx Phenomenon	Appearance of Aqueous Vein	Recipient Vessel	Influx Phenomenon
1	No large aqueous vein found		—	No large aqueous vein found		—
2	Clear	Stratified	Blood	Clear	Stratified	Blood
3	Clear	Stratified	Blood	Clear	Stratified	Blood
4	Clear, clear	Stratified	Aqueous	Clear, pink	Stratified	Aqueous
5	Clear	Pink	Blood	Pink	Pink	Blood
6	Clear, clear	Stratified	Aqueous	Pink, stratified	Stratified	Aqueous
7	Clear, clear	Stratified	Blood	Clear, stratified	Stratified	Blood
8	No large aqueous vein found		—	No large aqueous vein found		—
9	Clear	Stratified	Blood	Clear	Stratified	Blood
10	Clear	Stratified	Aqueous	Clear	Pink	Blood
11	No large aqueous vein found		—	No large aqueous vein found		—

transmission of the vis a tergo. Another proof of this is the existence of cases of essential venous hypertension without any other cardiovascular symptomatology (for example, the syndrome of venous hypertension of Villaret due to an endocrinal disturbance and Tarsitano's syndrome of essential venous hypertension).

If we are led to believe that there is a difference between normal subjects and glaucomatous patients, limited to the comportment of systemic venous pressure, we should try to explain its causes and consequences.

Because the study of the systemic venous pressure gives us exact data about the function of the right ventricle, it could be that in glaucomatous patients there is a disharmony between right and left heart, possibly causing the venous hypertension. This disharmony, however, must be limited, otherwise we should also find an increased arterial diastolic pressure. In a paper on this subject, Rossi[23] found instances of such a pressure increase, which, however, was not present in our patients.

Perhaps the cause of the systemic venous hypertension and of its inverted rhythm may be not an organic alteration of the cardiovascular system, but only the expression of a special constitutional state.

Whatever is the cause, this venous hypertension and the inversion of the diurnal systemic venous pressure curve appear to affect the intraocular pressure. Unilateral intraocular pressure increases due to arteriovenous aneurysm have been previously found. Bedrossian[24] reported a case of glaucoma associated with mediastinal tumor which seriously interfered with venous return and produced marked venous engorgement in the upper body and head. The provocative venous pressure test, consisting of compression of the neck veins, slightly affects the intraocular pressure of normal eyes but produces a considerable rise of intraocular pressure in glaucomatous eyes and changes in aqueous veins of most eyes.

In their papers on episcleral venous pressure both Thomassen[3] and Bain[7] agree about a direct influence of pressure variations in these vessels on the intraocular pressure: When the pressure in the episcleral vessels increases, a consecutive rise of the intraocular pressure follows, and, on the contrary, when the episcleral vessel pressure decreases, the intraocular pressure also begins a descending phase.

Photographic observations of Dobree[6] demonstrate that a rapport exists between changes of the episcleral vein diameter and ocular tension: During the phase of low intraocular pressure many formerly invisible capillaries become injected and the diameter of the veins is remarkably increased, while a certain constriction of the vessels is present during the phase of higher tension.

My observations about the changes in the appearance of the aqueous veins and the changes of the influx phenomena relative to the moment of minimum and maximum systemic venous pressure also seem to prove this influence of venous pressure on intraocular pressure. In some ways, however, my findings contradict those of Thomassen[3] and of Bain[7]: I found, in normal subjects, that the diurnal changes of the systemic venous pressure followed a curve exactly contrary to that of the intraocular pressure. The systemic venous pressure is increasing throughout the day while the intraocular pressure is decreasing. Thomassen[3] and Bain[7] instead referred to a constant parallelism, also in normal subjects, of the variations of the episcleral venous pressure and of intraocular pressure, which means a progressive decrease of the episcleral venous pressure during the day.

It must be assumed, therefore, that, in normal subjects, there exists an independence of episcleral venous pressure from systemic venous pressure. This is also true for some of the glaucomatous patients, but not for all of them; because, considering the observations of Thomassen[3] and of Bain,[7] in those patients with parallelism between diurnal systemic venous pressure

changes and diurnal intraocular pressure changes, one would also expect similar comportment of systemic venous pressure and episcleral venous pressure.

It is, therefore, concluded that, in normal subjects, the systemic venous pressure changes most probably do not influence the episcleral venous pressure and consequently the intraocular pressure; while in some glaucomatous patients, these systemic venous pressure changes may affect the pressure, and the appearance as well, of the episcleral venous vessels and aqueous veins and consequently the intraocular pressure.

The systemic venous pressure changes may be considered, in certain cases of chronic simple glaucoma, as the cause of an impeded aqueous outflow and therefore of the typical diurnal variations of the intraocular pressure; and in certain cases of congestive glaucoma they may be considered as a cofactor in initiating an acute attack.

Summary

1. There exists a significant difference between the systemic venous pressure of normal subjects and that of the glaucomatous patients in the early morning, in the sense that the systemic venous pressure of the glaucomatous patient is higher.

2. While in all normal subjects the systemic venous pressure increases during the day, in more than half of the glaucomatous patients the systemic venous pressure shows a decrease of the values resulting in a curve parallel to that of the intraocular pressure. This is graphically expressed in Figure 3.

3. While, in normotensive eyes, no significant changes were seen in aqueous veins, the aqueous veins of all glaucomatous eyes were clear at the time of the lowest systemic venous pressure.

4. In normotensive and in glaucomatous eyes, the facility of aqueous outflow showed no significant changes at the highest and lowest levels of systemic venous pressure.

5. No direct relation between systemic venous pressure and intraocular pressure of normal subjects was proved.

6. In more than half of the patients with chronic simple or congestive glaucoma, a parallelism between systemic venous pressure and intraocular pressure seemed to be present, suggesting a close relationship between the two.

Via Angelo Maj. 4.

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THE INTRAOCULAR PRESSURE OF PREMATURE INFANTS

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The high incidence and morbidity of retrolental fibroplasia have stimulated considerable interest and investigation of this condition. Pathologically, this disease shows vascular dilatation, edema, hemorrhage, and neovascularization.[1] If the intraocular pressure in the premature eye were below normal, these pathologic changes might be aggravated.

In his investigations of aqueous-humor ascorbic-acid levels, Kinsey has presented evidence which suggests that aqueous "secretion" may begin in the human fetus at the beginning of the seventh fetal month.[2] Presumably the intraocular pressure of the fetus would be low prior to this time. Since no information regarding the intraocular pressure of premature infants could be found, the present study was undertaken.

METHOD

Because of the small palpebral fissure and small cornea of the premature infant, the ordinary tonometer cannot be used to evaluate the intraocular pressure. A Soutter tonometer was used on normal, full-term infants, indentation of the cornea occurring

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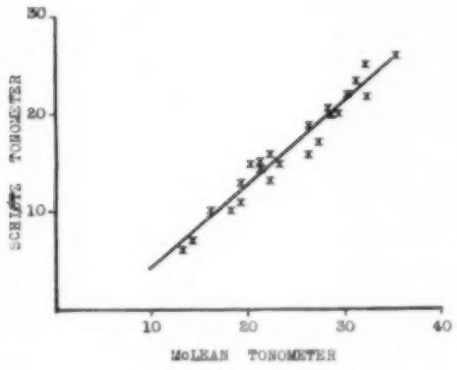

Chart 1 (Brockhurst). Plot of readings obtained on adult eyes using a certified Schiøtz tonometer and the altered McLean tonometer. The straight line represents Friedenwald's conversion data.

before the inertia of the spring mechanism was overcome, thus indicating a tension of less than 10 mm. Hg. on the Soutter scale. Schiøtz tonometer readings on the same eyes gave readings of 22 to 25 mm.

The Soutter tonometer was then applied to the cornea of a dead rabbit eye, a cannula in the anterior chamber being connected to a manometer. It was found that a reading of 10 mm. Hg on the Soutter tonometer, the minimal reading possible with this instrument, corresponded to a controlled intraocular pressure of 25 mm. Hg (Schiøtz).[3] This instrument clearly could not be used to uncover hypotony.

A McLean tonometer was selected and the foot-plate was turned down on a lathe to a diameter of seven mm. This permitted insertion of the instrument between the lids of a premature infant without causing tension. This altered McLean tonometer was then compared on adults with a certified Schiøtz tonometer. The results were then plotted and compared with Friedenwald's conversion data[4] (chart 1). It is apparent that this modified tonometer gives satisfactory readings.

The premature infants were examined in most cases as soon as their condition permitted, usually within a week after birth. Some measurements were done through the ports of the incubators, on the day of birth. Sugar nipples were used if the child would suck, and the eyes were anesthetized with 0.5-percent tetracaine solution. In most cases the infants were quiet and relaxed.

The fetal age at birth was calculated in days on the basis of the expected date of birth, assuming the normal gestation to be 280 days. Many of the measurements were not done on the day of birth. Therefore the actual age of the infant in days at the time of the measurement was added to the calculated fetal age, the total being termed the "adjusted fetal age."

Results

Intraocular-pressure measurements were made on 59 premature infants. The readings on the modified McLean tonometer were converted to mm. Hg (Schiøtz) in accordance with the data in Chart 1. The intraocular pressure varied from 6.5 to 33 mm. Hg (Schiøtz), with an average of 24.5 mm. Hg (Schiøtz). Chart 2 shows the tensions found for 21 infants whose adjusted fetal age was less than 240 days. In three infants hypotony was found, and these infants were less than 200 days of adjusted fetal age at the time of measurement.

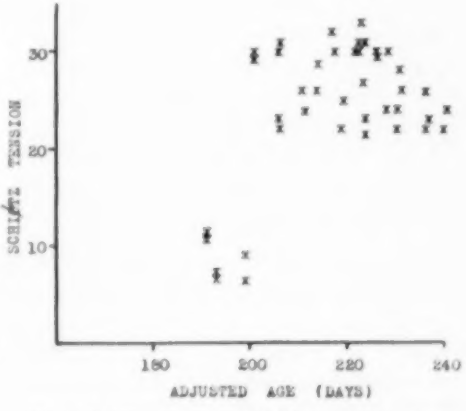

Chart 2 (Brockhurst). Initial intraocular pressures of 21 infants whose adjusted fetal age was less than 240 days.

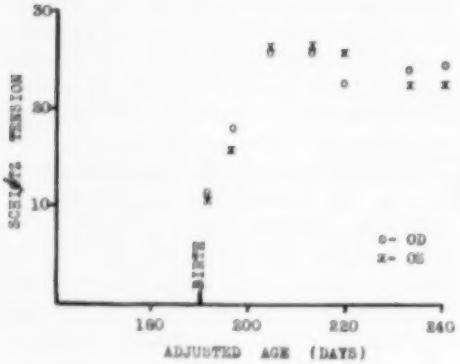

Chart 3 (Brockhurst). Intraocular pressures of baby "B."

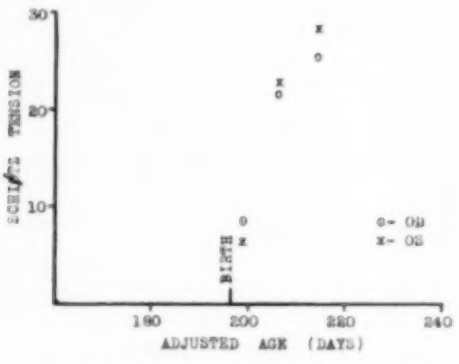

Chart 4 (Brockhurst). Intraocular pressures of baby "M."

Chart 3 shows the change in intraocular pressure for baby "B" who subsequently developed severe bilateral retrolental fibroplasia. It is apparent that the pressure began to rise toward the normal level at an adjusted fetal age of about 196 days. Chart 4 shows the changes in pressure for baby "M," the increase toward the normal level occurring at an adjusted fetal age of about 204 days. This baby died at the age of eight weeks, showing no signs of retrolental fiboplasia five days before death. The third infant with initial hypotony died six days after birth.

Of the 56 other infants, all of whom had normal intraocular pressures, adequate follow-up for at least six months was obtained in 33 cases.[3] Of these 33 babies, 13 developed retrolental fibroplasia of varying severity, 15 were entirely normal, and five died.

Comment

From this small series of cases it would appear that a low intraocular pressure is not a factor in the development of retrolental fibroplasia. In 13 cases the intraocular pressure was normal prior to the development of fundus changes.

The three infants who showed hypotony were all under 200 days adjusted fetal age. In two of these infants the pressures rose toward normal levels between 196 and 204 days. This rise in intraocular pressure may be further evidence that aqueous "secretion" begins just before a fetal age of seven months.

Summary

Measurements of the intraocular pressures of 59 premature infants were performed. The pressures were found to be normal in 56 infants, and in 13 of these babies retrolental fibroplasia subsequently developed.

In three infants hypotony was found, the pressures rising toward normal levels in two cases at a fetal age of about 200 days. This rise in pressure may coincide with the onset of aqueous "secretion" in the fetus.

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ELASTOMETRY OF THE EYE

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Since, at present, the glaucoma problem is the center of interest, it is no wonder that many workers in many parts of the world are studying it. Before trying to trace the cause of the high pressure, which is the principal symptom of this disease, it is necessary to know the exact pressure under various circumstances; until now this has been impossible. Neither the Schiøtz tonometers, in use for about 50 years, nor the later types of tonometers have been altogether successful for two reasons: (1) the inaccuracy of these instruments and (2) the influence of ocular rigidity.

Inaccuracies of the instruments can certainly be corrected. In many countries there are standardization stations which check the various models. Especially in America standardization has been emphasized during the last 10 years and is conducted by three tonometer checking-stations—one in New York, one in Chicago, and one in San Francisco. In this way many mistakes are corrected yet the results still vary greatly with tonometers of different makes.

The second source of error is, however, quite different. Ocular rigidity plays a very great part. This paper is concerned with this second source of errors.

The depth of indentation is considered the measure of intraocular pressure; however, the intraocular pressure is not the only factor influencing indentation. Other factors come into play—the nature of the ocular coats, their distensibility and rigidity. Ocular rigidity often varies to a considerable extent. Such other factors as size and shape of the eyeball, compressibility of the vascular bed of the chorioid, and the state of tension of the extraocular and palpebral muscles will not be considered here, since they are believed to be of little importance in glaucomatous eyes.

The cornea is a most important factor in ocular rigidity. The tonometric indentation is made on the cornea. The resulting dilatation in the main takes place in the cornea. The surface of the cornea is smaller than the surface of the remaining ocular coats so the dilatation of the cornea is relatively great. Posner[1] recently said that "variations in ocular rigidity play an important role in the interpretation of tonometric readings in many cases." Friedenwald[2-4] and his collaborators have done especially important work in this field.

In determining the intraocular pressure with the Schiøtz tonometer, one starts with the supposition that the coats of the eye to be measured possess a normal average rigidity. If the cornea (of the coats of the eye the cornea is the most important part in this investigation) is more rigid than normal then the Schiøtz instrument gives too high results; if the cornea is less rigid, the results are too low. The point is to know how great the error of measurement is, or rather how great the real intraocular pressure is.

According to Friedenwald it is possible that, in rare cases, owing to changes in rigidity, the readings of the tonometer at normal intraocular pressure can rise to 35 to 37 mm. Hg; this possibility must, according to him, always be considered when glaucoma is suspected.

To determine the influence of rigidity Friedenwald has worked out a method which is based on measuring the pressure with two different plunger loads—7.5 and 10 gm.—and then estimating the real intraocular pres-

sure precisely by application of the exact correction factor which depends on the difference in reading obtained with the two weights. This correction factor is based on the fact that, in eyes with above-normal rigidity, the pressure when measured with the heavier weight gives a higher reading than when measured with the lighter weight; in eyes with normal rigidity, the readings are the same; in eyes with below-normal rigidity, the readings are lower.

Friedenwald, however, points out that, when the rigidity is normal, the readings are always equal, making various measurements necessary. If, however, the readings with the two weights always differ in the same way, certain deductions concerning the ocular rigidity and, therefore, the real intraocular pressure may be made.

In 1950, after pointing out that only by studying the combined pressure and rigidity can the exact intraocular pressure be determined, Friedenwald discussed the clinically important question of whether there are human eyes in which ocular rigidity diverges markedly from the average, and concluded that the answer must be, "yes." He then presented a table, based on his earlier calculations, from which the calculated pressure and rigidity could be read. For accurate determinations a nomogram is needed.

Errors are not excluded from these measurements, especially because the tonometer must be removed from the eye after every reading to be loaded with the other weight. Duration of the pressure measurement is also important because it affects the aqueous-humor flow.

A different method of approach to this problem is based on ballistic elastometry —*ballistic elastometry* is emphasized because it differs essentially from ballistic tonometry.

Ballistic elastometry, as used in ophthalmology for measuring the elasticity, is based on the use of a light; ballistic tonometry, for measuring the ocular hardness, makes use of a heavy hammer. With ballistic elastometry, the elasticity limit is never exceeded; in ballistic tonometry, however, the elasticity limit is exceeded. Since previously all ballistometers were "hardness-meters," unfit for elastometric determinations, it was only after we started to use an extremely light hammer that we began to approach our objective.

The ballistic measuring of hardness was first investigated by Thoulet (1883), a French mineralogist. Noyons (1908) was the first to introduce this method into physiology. He tried to determine the hardness of the eye. Later Obbink (1931) also used a heavy hammer to perform tonometric examinations on eyes.

About the same time, Vogelzang (1927) started his investigations with the ballistic elastometer. He was the first to use a light-weight hammer to determine the elastic values of the eye and his apparatus can be considered the first ballastic elastometer. However, Vogelzang's hammer was still too heavy and, the direction of impact not being defined, his determinations were made on the sclera. He was also the first to apply this method to the human eye.

Ballistic tonometry was, by its very nature, destined to fail since it had to be done with a heavy hammer and the eye, naturally, cannot stand this. When the hammer was made lighter, without realizing it, however, one reached the domain of ballistic elastometry. From 1934, I have systematically investigated ballistic elastometry and I now think the problem is nearing solution.

Ballistic elastometry as executed with a light hammer will be called "direct elasticity measuring" in contrast with the method of Friedenwald, which I designate as the indirect method.

One purpose of this essay is to call attention to my elastometer (fig. 1). The apparatus was demonstrated at the XVI International Congress in London but has not up to now been reported in the literature.

This quadrant balance elastometer measures corneal rigidity by the direct method; "rigidity" being considered as elastic resistance to indentation. Its construction is

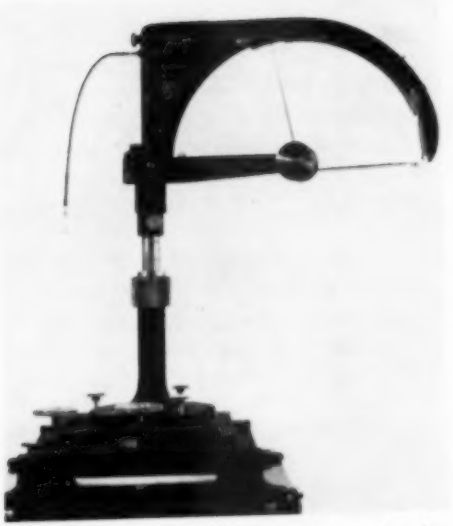

Fig. 1 (Wiegersma). The elastometer, showing the ballistometer in its mounting with the hammer in the starting position. The hammer may be released with the wire control. Two plastic plates limit the space in which the hammer moves. These plastic plates have openings which permit air to escape when the hammer drops so that the force of the blow will not be checked. There is a metal plate with a distal opening at the bottom of the air spaces. When the hammer is in an horizontal position (in balance), the hammer-head handle projects for some millimeters through the opening at the bottom; this simplifies correct adjustment of the patient's eye. A water-level is built into the apparatus.

based on two elementary concussion laws:

1. In a straight, central, not elastic concussion, when one body stands still and the other has proportionately little mass, the colliding body does not bounce back.

2. In a straight, central, completely elastic concussion when one body stands still and the other has proportionately little mass, the colliding body bounces back at the same speed.

In my experiments, the body standing still is the eye; the colliding body with proportionately little mass is the hammer. The straight, central concussion is used, exclusively, that is, the direction of the movement of the hammer is toward the normal contact-point and that normal contact-point coincides with the point of collision which is at the center of gravity of the eye.

Since there is, therefore, but one exact point of collision, the hammer must be light (of the least possible mass, hollow, and of aluminum), must possess very little air-resistance (streamlined), must have little friction at the hanging points (rubies), and a small velocity (counterweight). It must not vibrate upon concussion (shape of a triangle) and must produce little energy (small velocity, small weight, and counterweight close to the turning point). Moreover, the patient must be examined in a recumbent position.

Figure 2 is a diagram of an elastometer of new design. The hollow aluminum hammer, hanging in balance and streamlined, is hung in rubies and has a triangular handle. For balanced hanging, counterweight (A) is required; this weight, at the same time, slows down the velocity. The counterweight which, as already observed, must lie as close as possible to the turning point (small energy), is hung in a round aluminum box (B) in the center (P) of which the axis is located (with a view to minimum air-resistance). The center of gravity (Z) has been placed close to (for sensitivity) and perpendicularly under (for balance) the turning point. The handle of the hammer (H) is hollow, of aluminum, and in the shape of a triangle (vibration proof); at the end of the handle of the hammer is the hammerhead handle (h), bearing the hammerhead (k).

If this hammer is dropped from the vertical high position, then, having no resistance, it will swing on to the vertical low position. As resistance, though for the greater part small, cannot be eliminated entirely, the hammer is slowed down and does not reach the extreme low position. In order to attain this position the hammer must be given more energy; therefore, the center of gravity must be lowered. To do this, the release must be shifted from a vertical position on the top somewhat to the left to the exact point at which the vertical low position will be at-

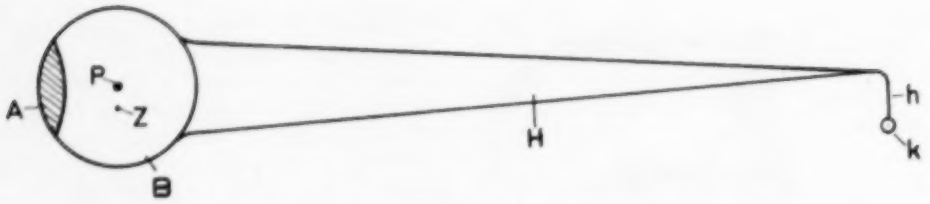

Fig. 2 (Wiegersma). Diagram of an elastometer.

tained. This is called correction of the error, which here, because of the small resistance of the hammer, is extremely slight. Since this resistance is extremely slight, it may be ignored when the calculations are made. In principle the calculations are done as has been previously described.

The quotient of the initial energy (denominator) and the final energy (numerator) of the hammer are multiplied by 100 (this is SQ, the concussion quotient or stress quotient).

$$SQ = 100 \frac{mh' + fs}{mh - fd}$$

h = the drop of the center of gravity
h' = the rising-height of the center of gravity
m = the mass of the hammer
fs and fd the resistances in rising and falling, respectively

Under the given circumstances we can neglect the resistances, and get then:

$$SQ = 100 \frac{h'}{h}$$

or

$$SQ = 100 (1 - \cos a)$$

in which formula *a* forms the rising angle after the concussion.

These SQ values are absolute numbers which vary from 0 to 100; 0 stands for the horizontal position, 100 for the vertical one. If the hammer is now dropped from the release point (bumping up against the eye in a horizontal position) it will swing back in hypothetically perfectly elastic concussion to 90°, as the resistances in the oscillation system are fully compensated and therefore reach point 100 on the scale division. At the nonelastic concussion the hammer will not swing back. So all possible values may be found—from perfectly elastic = 100 SQ, to nonelastic = 0 SQ.

The rigidity, determined according to the plastic loss, is the complement of the SQ values, and these we call PL (plastic loss).

$$PL + SQ = 100$$

Since PL also varies from 0 to 100, the rigidity can be expressed directly in absolute values.

Is this elastometer of practical use?

With the tonometer, the sum of the rigidity of the cornea and the real intraocular pressure can be determined. The real intraocular pressure is the real pressure of the eye as it might be determined manometrically. The sum of the rigidity and the real eye pressure is called the unreal eye pressure.

With the elastometer, under special circumstances, however, only the rigidity of the cornea is measured and that in the following way:

If the hammer is dropped on an imaginary, thin, completely elastic cellophane cornea of a phantom eye and the phantom eye is filled with water under moderate pressure, so that the interior friction at concussion may be ignored, when the elasticity of the water is measured, it is found to have a constant value of about 100 SQ.

When, however, the membrane which acts as a closing valve becomes less elastic, either because of increased thickness or change of material, then the rise will no longer be complete for it will be checked by the membrane; there is now an elastic resistance against indentation, in other words a certain rigidity (PL).

Since SQ and PL complement each other and the sum is 100 the rigidity of the membrane can be measured. The error, if any, of the inward friction at a stated moderately high pressure (called critical pressure) may be ignored because the applied energy at the concussion is extremely small. At a rise of pressure above this critical pressure, the deflection of the elastometer must remain constant, if this deflection is only dependent on the elasticity of the contents and the rigidity of the wall and is not influenced by the pressure; it, therefore, changes only when the rigidity changes. This is indeed the case. The elastometer above the critical pressure is independent of the pressure and so it is not a hardness meter but an elasticity-rigidity meter (fig. 3).

If, instead of on a phantom eye, the experiments are done on a human eye, and the examination is the same, the very same phenomena are produced as with the thin cellophane (fig. 4).

What is almost immediately apparent but is seldom considered is the extremely low PL (low rigidity) of the human cornea (0.9 mm.—about 30) compared with that of cellophane, which may certainly be considered a semiorganic membrane; the PL

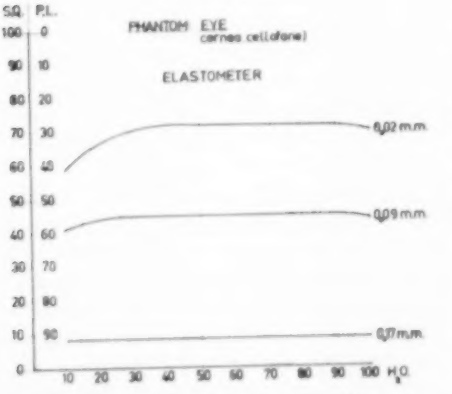

Fig. 3 (Wiegersma). Experiments with a phantom eye showed that, above a certain pressure, when the pressure is raised further, only the change in rigidity affects the PL.

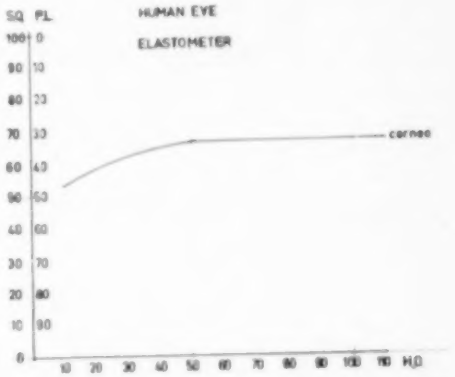

Fig. 4 (Wiegersma). Experiments with a human eye. Here the critical pressure is ± 50 H_2O = 35 mm. Hg. Above this pressure the graph line becomes horizontal.

of cellophane (0.17 mm.), so much thinner than the cornea, is 92! This is remarkable and emphasizes that the PL (rigidity) depends both on the thickness and the nature of the cornea.

At the ballistometric examination of the human eye it is possible to determine directly the rigidity above a pressure of 35 mm. Hg. This is the first advance and is extremely important. The rigidity of the wall can be expressed in an absolute number. With the aid of the tonometer may be determined, as examination takes place, the sum of rigidity and real intraocular pressure (unreal eye pressure).

It is now important to discover a way to find the real intraocular pressure in glaucomatous eyes, independent of the value of the wall. I think I have found this way by means of a double graph; this should be considered the second advance, closely related to the first one (fig. 5).

In order to draw up the double graph shown in Figure 5, several extirpated human eyes were examined tonometrically and elastometrically and the resulting values recorded in the graph. The technique was as follows:

The eyes to be examined were connected by means of a needle, which was brought into the anterior chamber, with the water-

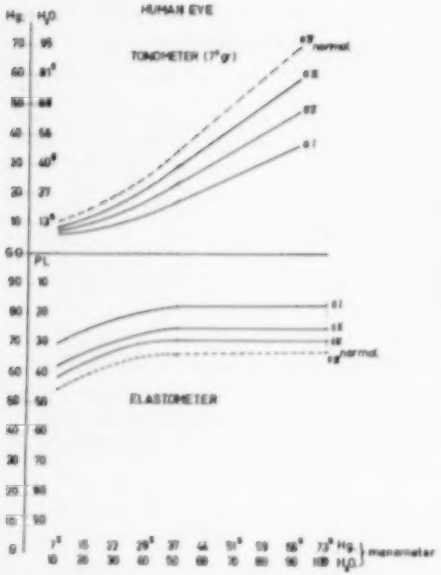

Fig. 5 (Wiegersma). The double graph consists of an elastometer recording and a tonometer recording. The common abscissa represents the manometer pressure; the two ordinates, one above the other, represent the elastometer and tonometer values.

manometer; in this way we could put the desired real pressure into the eye. A tap in the system provided a shut-off at tonometric examination. The pressure was raised by 10-cm. steps and the values found with the tonometer (elastometer) were noted. The data are presented in the graphs. Thus were found the various pressures characteristic for each eye.

I have been able to examine ballistometrically and tonometrically only two extirpated eyes. The values are found in the double graph (fig. 4). One of these two eyes proved to give normal tonometric values and the elastometer value has, therefore, been indicated as a normal value. Other elastometer values have been found in vivo in glaucomatous eyes (buphthalmos). These are real values. The tonometer values belonging to them have been inserted which is, of course, not quite correct; however nothing can be said against it when the purport of the examination is considered. If this publication should meet with wide response, then these experiments will have to be repeated to obtain more exact values.

Every eye has its characteristic pressure and PL lines, which belong together in pairs. In case of increasing rigidity the pressure, and PL lines going together diverge on the double graph, as the tonometer gives higher readings at rising rigidity, the elastometer lower readings.

By means of this double graph it is possible to find in glaucoma patients not only the absolute cornea rigidity (PL value) but also the real eye pressure—the PL line can immediately be determined by elastometric examination. When this line is known, the pressure line belonging to it is also known. The (unreal) pressure can now be measured with the tonometer. Since the ordinate value of the characteristic pressure line belonging to the PL line has been determined, it is possible to find at the same time the abscissa value belonging to it—the real pressure value.

In this way, I think, is found a good solution for an old problem and that according to an exact method. Naturally, an exact double graph of the characteristic pressure and PL lines is of great importance.

Several patients have been examined by me according to this double-graph method. I have the impression that, in cases of long-standing glaucoma, the rigidity of the cornea is reduced so that the pressure is higher than is found with the tonometer. This is especially true in juvenile glaucoma (buphthalmos).

When examining patients with the ballistometer, many things must be considered. In the first place, since the eye must be hit at the exact center, fixation apparatus has to be used for the second eye. It is necessary to immobilize the head (sandbags). An eye speculum must be inserted, the eye anesthetized with pontocaine and always kept moist —a dry cornea sticks.

If more values are now found, the highest is the correct one; several examinations

should be made until the highest value is constant. The error made by the elastometer is very slight, practically nothing. It is important that only one type of instrument be used, otherwise the same confusion arises as with the tonometer.

Tonometric determinations in glaucoma are, for the greater part, incorrect. Glaucoma eyes are not normal, a statement which includes their corneal rigidity. The tonometric readings might be considered as unreal pressure values in contrast to the values found according to the method herein described—which might then be called the real pressure. At any rate in cases of glaucoma one may speak of the real intraocular pressure only when the examination has been made by the combined tonometric-elastometric method.

N. Ginnekenstraat 18.

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MEASUREMENTS OF CORNEAL ELASTICITY

In relation to disease, using the Wiegersma elastometer

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The ballistic method for measuring intraocular pressure was introduced by Vogelsang[1] in 1927. Ingenious devices were designed for this purpose by Vogelsang,[2] Weve,[3] Obbink,[4] and Wiegersma.[5] Wiegersma's instrument attained the highest degree of mechanical efficiency. However, like other instruments in this class, it showed a lack of consistent and definite responses to changes in intraocular pressure. For this reason the instruments were eventually abandoned as devices for measuring intraocular pressure.

The recent developments in the surgical treatment of diseases of the cornea have prompted us to investigate the possible applicability of the ballistic principle to the study of the physical properties of the cornea and of corneal disease. The elastometer of Wiegersma is uniquely suited to this purpose because its hammer, which is extremely light, responds chiefly to the viscous and plastic properties of the tissues at the point of impact. By the same token, the influences of ocular rigidity and of intraocular pressure are rendered minimal.

From the Manhattan Eye, Ear, and Throat Hospital. Presented at the XVII International Congress of Ophthalmology, New York, September 12-17, 1954.

Description of the instrument

The Wiegersma elastometer consists essentially of a hammer, the head of which is a two-mm. ivory ball. The arm is 150-mm. long and is mounted in a jeweled pivot in the center of a calibrated quadrant. It is counterbalanced so as to be extremely light. The resting position of the hammer is in the horizontal plane (fig. 1).

When the hammer is raised to the vertical position and then released by a tripping mechanism, it traverses an arc of 180 degrees and then returns to its original position, less a small distance lost by friction. If an object is struck by the hammer the instant it reaches the horizontal position, the hammer rebounds upward. The amount of rebound is measured on the quadrant of the elastometer. This quadrant is calibrated from zero

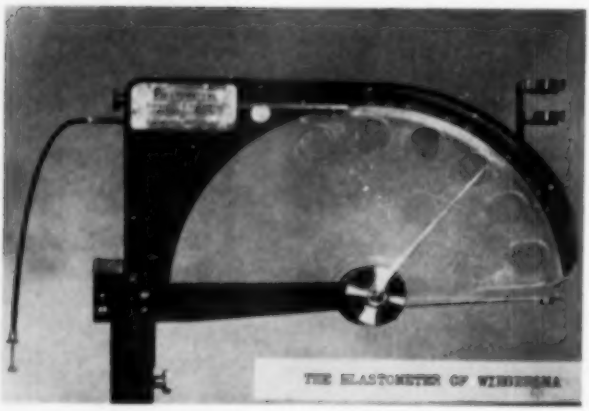

Fig. 1 (Mamelok and Posner). Elastometer of Wiegersma in position for making measurements. The instrument is mounted on a mechanical stage. A fixation light may be attached to the frame of the instrument. The guide ring at the extreme right is placed two millimeters above the cornea and aids in positioning the hammer so that it strikes the center of the cornea.

Pontocaine (0.5 percent) is instilled in the eye, the lids are separated by means of a speculum, and the patient is instructed to keep both eyes open. The hammer is locked in the vertical position by a tripping mechanism which is released by pressing the cable release at left.

to 100. The units are proportional to the force which acts on the ivory ball at any point along the arc. The reading of the instrument may be expressed as the ratio of the height of rebound to the height of impact. Wiegersma calls this ratio the "Stossquotient" and it will hereafter be referred to as "S.Q." The S.Q. may be expressed as $100\ h'/h$, h' being the height of the rebound and h the height of impact. S.Q. may also be expressed as $100\ (1 - \mathrm{Cos}A)$, where A is the angular deflection of the hammer. The reciprocal of S.Q., is termed "plastic loss" (P.L.). The sum of P.L. and S.Q. equals 100.

In elastometry, in contrast to impression tonometry, the influence of ocular rigidity is reduced to a minimum because the indentation produced by the extremely light hammer is relatively insignificant. The decrease in momentum of rebound as compared to impact is accounted for by the dissipation of energy as heat by the viscous and plastic resistance of the ocular tissues. The greatest variations in the readings result from differences in the physical nature of the tissues tested.

If the cornea were perfectly elastic, none of the momentum would be lost, except from friction, and the hammer would rebound to the maximum position with relation to its starting point. Any additional loss of momentum is a measure of the plastic or viscous flow in the cornea and, to a much lesser extent, in the intraocular fluid.

Our data are essentially in agreement with those of Wiegersma.[6] Using a cellophane cornea, Wiegersma found that the S.Q. decreased as the thickness of the cellophane increased. With cellophane membranes of 0.02 to 0.04 mm. in thickness, Wiegersma noted an increase in the S.Q. when the hydrostatic pressure was increased up to 30 cm. of water, after which the S.Q. levelled off.

Personal observations

Elastometer measurements were made, using an artificial eye which consisted of a metal cylinder covered by a rubber membrane to represent the cornea. The cylinder was filled with water and was connected with a water manometer. By means of a stopcock, the connection could be left either open or closed. Measurements were made with the manometer open and closed (table 1). The closed manometer system simulates conditions as they obtain in the intact eye. The open manometer system, in the case of tonometry, eliminates the increase in intraocular pressure caused by the weight of the tonometer. The table shows that in the case of the rubber cornea the S.Q. is high and varies only slightly with the hydrostatic

TABLE 1

SHOWING COMPARISON OF MEASUREMENTS WITH ELASTOMETER AND SCHIØTZ TONOMETER (5.5 WEIGHT) ON RUBBER CORNEA CONNECTED WITH WATER MANOMETER

Manometeric Pressure (cm. of water)	Open manometer		Closed manometer	
	Elastometer SQ	Tonometric (mm. Hg.)	Elastometer SQ	Tonometric (mm. Hg.)
5.0	70	2	74	17
7.5	72	3	75	20
15.0	76	4	78	25
30.0	78	21	82	32

pressure when compared with tonometric readings. The differences between the open and closed manometer readings are much smaller with the elastometer than with the tonometer. In general, the closed manometer gives higher readings and a smaller range than the open manometer.

EXPERIMENTS ON SILICONE PUTTY

Silicone putty* was used because of its unique properties. It has the consistency and plasticity of soft putty, but its response to an instantaneous impact is similar to that of a liquid since it is not compressible. Repeated measurements with the elastometer gave fairly consistent readings, the S.Q. ranging between 68 and 69 no matter whether the surface of the putty was spherical, flat, or concave. This lack of dependence of the S.Q. on the curvature of the surface tested was paralleled by our clinical measurements of human corneas of varying curvatures.

EXPERIMENTS ON ENUCLEATED HUMAN AND CAT EYES

The eyes were connected with a water manometer by puncturing the anterior chamber with a 22-gauge needle. We found that, as in the case of the rubber cornea, the elastometer readings did not show significant variations between open and closed manometer systems, whereas the tonometric tensions were approximately twice as high with the closed as with the open manometer.

*"Bouncing putty" 9991-1, manufactured by General Electric Corporation.

MEASUREMENTS ON PATIENTS

Measurements were made on 50 eyes belonging to 36 patients. The most striking observation was the relative lack of correlation between the elastometer reading and the ocular tension. This is dramatically illustrated in a patient (G. P.) with bilateral chronic simple glaucoma. The tension was: O.D., 23 mm. Hg (Schiøtz); O.S., 62 mm. Hg. The elastometer S.Q. was O.D., 70; O.S., 69.

Elastometer readings showed marked differences between two eyes in which the corneas differed in their physical properties. Case J. Y., male, aged 32 years, had a dynamite injury to both eyes, steel and carbon particles having become embedded in both corneas. A clear lamellar graft was present in the left eye. Tension was: O.D., 25 mm. Hg; O.S., 17 mm. Hg. Ocular rigidity was similar in both eyes. Elastometer S.Q. was: O.D., 69; O.S., 57. In this case, the left cornea was considerably thicker than the right because of the lamellar graft.

In another case, E. C., female, the diagnosis was corneal dystrophy, left eye, and penetrating graft, right eye. Tension was: O.D., 20 mm. Hg; O.S., 20 mm. Hg. Elastometer S.Q. was: O.D., 69; O.S., 50. The lower elastometer reading corresponded to the diseased cornea.

P. McB., female, had keratitis of the left eye. The eye was injected. There was a penetrating graft in the right eye. Tension was: O.D., 26 mm. Hg; O.S., 24 mm. Hg. Elastometer S.Q. was: O.D., 59; O.S., 41.

Here again, the diseased cornea gave a much lower S.Q. than the healthy graft.

Sources of error

It is important to position the patient's eyes so that the hammer of the elastometer strikes the cornea in its center and perpendicularly to its surface. This is especially important in keratoconus. Case M. B. illustrates this point. The diagnosis was bilateral keratoconus. The elastometer gave an S.Q. of O.D., 56; O.S., 52, when the ball struck the apex of the cone. On striking the cornea three mm. temporal to the apex, the S.Q. was: O.D., 48; O.S., 38.5. In general, cases of keratoconus gave lower than average normal readings.

An even greater source of error resulted from allowing the surface of the cornea to dry. Drying dampens the rebound and gives a much lower S.Q. For example, in the case of H. J., the elastometer gave an S.Q. of 65 for each eye, but dropped to 44 when the cornea was allowed to dry for one minute.

Discussion

Our personal observations corroborate and amplify those of Wiegersma. The elastometer responds to changes in the intraocular pressure but to such inconsequential degree that it is of no clinical value as a tonometer. This is especially so because the physical properties, such as thickness of the cornea, moistness of the corneal surface, and the density and consistency of the corneal stroma, affect the reading to a greater extent than does the hydrostatic pressure of the underlying liquid.

Wiegersma[4] expresses the opinion that the elastometer may aid in the estimation of ocular rigidity and, in conjunction with the tonometer, give a truer picture of the intraocular pressure. Our experimental and clinical results have shown that this is not the case, since ocular rigidity plays hardly any role in the elastometer readings. The corneal indentation produced by the impact of the extremely light hammer is so small that the resulting distention of the ocular shell is also minimal. Instead, the elastometer measures the elasticity (or rigidity) of the cornea itself, which depends not so much on the intraocular pressure as on the nature of the material of which the cornea is composed.

Summary

1. The elastometer of Wiegersma is a ballistic instrument which measures the response of the eye to an instantaneous impact.

2. The factors which may affect the elastometer readings are: Intraocular pressure, ocular rigidity, thickness, and other physical properties of the cornea.

3. The elastometer proved most valuable in detecting and evaluating differences in the physical properties of the cornea. In cases of interstitial keratitis, corneal dystrophies, penetrating and lamellar grafts, and in drying of the surface of the cornea, the elastometer reading showed significant variations whereas the tonometer did not.

4. The elastometer does not supply the same information as the tonometer but it may prove valuable in conjunction with tonometry. Preliminary investigations have shown that the elastometer may be useful in studying corneal disease and the fate of corneal grafts.

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COMPENSATION FOR OCULAR INJURIES IN THE UNITED STATES

Review of progress

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This subject was reviewed by me under the same title (The American Journal of Ophthalmology, **28**:856-871 (Aug.) 1945). The review was based on data gathered by the American Medical Association Committee on Visual Economics in 1940. There was found a bewildering diversity of policies and practices in the United States in disability rating for ocular injuries, growing out of the fact that workmen's compensation legislation is under the separate jurisdictions of 48 States. For the same damage to the visual apparatus, from the ophthalmologist's standpoint, as many as 27 different awards in terms of money were found possible.

At that time workmen's compensation legislation was relatively recent in the United States. It had been introduced on the continent of Europe in 1882, extended to England in 1897, but the movement only reached the United States in 1910. It made steady headway throughout the country, however, and now all the 48 States of the Union have workmen's compensation laws.

The A.M.A. Committee on Visual Economics took steps to meet the problem of compensation for ocular injuries, and reported its recommendations in 1925. There was then, however, a majority and a minority report. In 1941 the committee revised its report. The committee, now a subcommittee of the Council on Industrial Health of the A.M.A., is in the process of revising the "Present standard methods of estimating the percent loss of visual efficiency."

I, as chairman of the committee on Legal Ophthalmology of the Pan-American Association of Ophthalmology, undertook a survey of the situation in the Americas, by means of questionnaires sent to the 21 republics and Canada. The collection of data has not been completed outside of the United States and Canada.

Of the 48 States of the Union circularized, data on 46 States and the Commonwealth of Puerto Rico have been obtained. Important and essential data are on hand as far as the United States is concerned, which should be brought to the attention of ophthalmologists dealing with the problem of disability rating for eye injuries under workmen's compensation. This preliminary report is part of the report to be submitted later to the Pan-American Congress of Ophthalmology, to be held at Santiago, Chile, in February, 1956.

The questionnaires for the United States were planned principally to find out how much progress has been made toward the acceptance by the States of the American Medical Association committee's recommendations in the matter of compensation for eye injuries. According to the 1940 data, only six States of the 30 States then reporting had adopted the recommendations of the committee of the American Medical Association in their entirety. Five States used some modification of the committee's

* The statements and conclusions are those of the author, and do not necessarily reflect the opinions or policies of the Veterans Administration.

recommendations, with a compromise between "before correction" and "after correction" visual acuity as the basis. Nineteen States used "uncorrected" visual acuity as the basis, either in connection with the tables of the committee, or with a variety of tables of their own.

My own data collected from 46 States show that only eight States use the A.M.A. method, 13 States use a modified method with a compromise between "corrected" and "uncorrected" visual acuity, and 25 States still use "uncorrected" visual acuity as the basis. Other items logically related to this central item in the questionnaire were surveyed and will be discussed in this review.

Optical aids in compensation

The ophthalmologist who daily prescribes optical aids for his patients is disconcerted by the policy of compensating injured eyes without reference to optical aids, now the policy in more than 50 percent of the States; and this, despite the many years of educational efforts of 8,000 ophthalmologists and EENT physicians and 20,000 optometrists, as well as many private philanthropic agencies operating in the field of promoting good vision and its rehabilitation and protection, and despite the prestige of the American Medical Association.

To meet the challenge of this puzzling situation, and to plan for its remedy, it is necessary to gain a better insight into the philosophy underlying workmen's compensation, and the magnitude of the problem. This discussion therefore will center on this aspect.

In the first place, the policy of compensating for eye injuries "before correction" should not be hastily attributed to the ignorance of lay administrators. It must be realized, too, that, in the United States, the approach to disability rating is based on physical impairment rather than economic loss. A grudging concession to the latter is the policy of making the worker's varying wages the basis for the weekly payment.

One State, Pennsylvania, does not consider permanent partial loss of vision unless it exceeds 50 percent. One other State expressed concern about "loss appraisals not comprehending vocation as well as actual loss."

The practically universal rejection by the States of consideration of the condition of the uninjured eye in compensation, as originally recommended by the American Medical Association committee, that is, of rating eye damage in terms of total disability, is another expression of this principle of giving consideration only to physical impairment.

Exceptions are usually made in the case of workers already blind in one eye, who sustain an injury to the good eye. Special "second" or "subsequent" injury funds have been created in more than half of the states to take care of such cases. These funds are built up by the payment into them by insurance carriers of one percent of all awards for fatal accidents in industry. Incidentally, practically all moneys thus collected are used for eye cases in order to encourage the employment of one-eyed workers without any one carrier assuming liability in case of loss of the good eye in an accident.

Another fundamental fact to be noted is that the workmen's compensation acts often prohibit the workers waiving their disabilities. These policies, bewildering to the ophthalmologists, of using "uncorrected" vision as a basis, have been fought out in the courts and sustained by them, with perhaps an occasional inconsistency, the courts' decisions resting on the basis that workmen's compensation legislation is social legislation, for the benefit of the industrial worker.

The courts, for instance, hold the employer or carrier liable for the entire expense of disability when a previous incurred disability has been aggravated or accelerated by an industrial accident. The fact of acceptance of a worker for a job, and insuring him against accidents by a standard

premium is considered as tantamount to the taking of previous state of health into the bargain.

The arguments advanced by some administrators for the "uncorrected" vision as a basis are, however, not substantial. They claim:

1. That candidates for employment find it harder to obtain jobs if they wear glasses. This should not be true now with the high level of employment and the campaign for employment of handicapped persons, particularly of veterans, since World War II.

2. That, in some occupations, glasses are an impediment. This also has lost much of its validity in view of the use of safety goggles in many industries, campaigns for enforcement of their use, and the increasing use of optical aids by the population as a whole.

3. That for workers with defective vision, whether correctible or not, to be penalized for it would be as reasonable as reducing award because of a low life expectancy in case of the death of a worker, 65 years of age, who suffered an accidental death in industry. However, while low life expectancy is not a reversible situation, defective vision when correctible is reversible.

4. That glasses are "crutches." This is the result of propaganda against glasses by Bates followers and others, which has to be combatted by our own educational campaign of the public.

The most serious argument against "before correction" as a basis is the obvious inequity of giving the same amount of compensation for a minor damage of an eye in the presence of pre-existing "industrial blindness" "uncorrected," as for a serious injury to a pre-existing normal eye of a fellow worker. As an illustration, one administrator reports having had to make an exception in a case where the visual acuity before the accident was 20/200, but corrected to 20/30, and after the accident remained "uncorrected" 20/200, but "after correction" was only 20/100. In this case the worker would have been the loser of course if the regular procedure had been applied.

Another serious argument against the use of "uncorrected" as a basis is that the ophthalmologist, whose opinion must be used by the administrator before making an award, is likely to be warped in his judgment in the matter of the causal relation of minor pathologic conditions, the effect of which on visual acuity becomes a matter of speculation, under the circumstances. It is discouraging to try to effect an adequate correction which will be discarded by the Workmen's Compensation Commission.

Compensation for the rare errors of refraction directly attributable to injury, such as astigmatism, or loss of lens, or of accommodation, is of course valid and not involved.

If these points were clarified and the real purpose of the use of "after correction" basis in compensation for eye injuries were emphasized as not designed to minimize the amount of compensation but to introduce equitable distribution between the various beneficiaries of compensation, actuarily available, administrators might be persuaded to reconsider the practice of using "uncorrected" vision as a basis.

It is evident that, from the standpoint of the ophthalmologist using "uncorrected" visual acuity as a basis, overpayment may be made to one group of workers—an overpayment which can be accomplished only by underpayment of another group of beneficiaries or by increasing premium rates.

A rough estimate of the magnitude of the problem should also help toward an understanding and possible ways of meeting it. On the basis of our draft-rejection figures and other statistics, 20 percent of the adult population has defective vision not correctible to normal, either in terms of central visual acuity for distance in one or both eyes or of binocular depth perception, or of both combined, not counting the color-blind and the night-blind.

In addition, some 20 percent of the popula-

tion wear or are estimated to be in need of optical aids to correct their defects and bring their vision to normal, again not counting the presbyopes. Thus, on the basis of 60 million industrial workers, some 25 million workers have industrial defective visual apparatuses, half of which are correctible to normal.

However, probably less than 150,000 of these 60 million workers suffer annually from industrial accidents involving their eyes. Of these 150,000 eye accidents involving 60,000 defectives, only about 15,000 in the whole country are found to be covered by compensation after correction of their pre-existing defects. This estimate is based on New York State pre-war experience, which shows approximately 500 permanent partial eye awards annually. The nationwide estimate is reached by multiplying the New York State figures by 30 in order to allow for increase of employment since 1940.

Of these 15,000 workers, visual acuity of 6,000 was originally subnormal—one half correctible to normal and the other half not correctible to normal. Without the use of optical aids, 27,000 more would be compensated without allowing for the noncorrectible pre-existing defects, and another 27,000 would be compensated if the pre-existing condition were ignored. The result would be that four times as many eye accidents would be compensated as would be if "corrected" vision were used as a basis. It should be borne in mind that those workers described as having vision not correctible to normal may have better visual acuity "corrected" than noncorrected.

The dimensions of the problem, large at first glance, shrink considerably upon further analysis. The administrator must have evidence of causal relation before he can make an award. This evidence is primarily medical and is made up of the opinion of the ophthalmologist treating the injured worker or the one who examines the claimant at the request of the administration, and who, by certifying that defective vision is not related to the accident eliminates a large group. In addition, if there is a record of a pre-employment eye examination, and the eye condition is found not to be aggravated by the accident, another large group would be eliminated.

Problem of binocular depth-perception impairment

It should be understood that in using the term of "corrected" and "uncorrected," or "before" and "after" correction, only visual acuity for distance is considered in those states where "uncorrected" is used as a basis. It is true in addition that 99 percent of all awards for eye injuries under workmen's compensation are made in terms of central visual acuity for distance. However, a third of the visual defectives in the population, because of heterotropias, anisometropias, maculopathies, and optic neuropathies, have disabilities involving the functions of binocular depth perception as well as central visual acuity for distance.

The American Medical Association committee properly devised a formula to take care of the function of binocular depth perception. The committee's method applies, however, only to disturbances in the binocular motor field due to diplopia. The problem of "corrected" and "uncorrected" arises because the use of prisms undoubtedly can overcome many cases of total or partial diplopia in the binocular motor field.

Binocular depth perception is also involved in several other situations. Hitherto monocular aphakia was considered the equivalent of the loss of use of an eye. It was assumed that, due to diplopia, the correction of the aphakic eye could not be worn and binocular single vision obtained. In addition, the loss of accommodation, severe visual field contraction with the cataract lens, and the erythropsias were taken into consideration.

With the development and the perfection of contact lenses (and also because of the Ridley operation), the proper compensation

for monocular aphakia after extraction or spontaneous absorption of a traumatic cataract is being reconsidered. Since contact lenses are said to be tolerated by only 50 percent of patients, and because of dust in the environment of many occupations, they are considered even less suitable for industrial workers.

Both in cases of diplopia in which the eye can still be used if use of the other eye is lost and in cases of monocular aphakia in which binocular depth perception can be achieved by means of contact lenses, with subsequent aphakia of the other eye, a person can hardly be considered blind. The general practice of awarding 100 percent loss of usable sight in the cases is not followed, (and "allowance" made for correction) in Pennsylvania, California, Connecticut, Wisconsin, and West Virginia. In Oregon, "corrected" vision is used as a basis in binocular aphakia.

Aside from diplopia and monocular aphakia, there is the problem of binocular depth perception in relation to the central scotomas of traumatic maculopathies and optic neuropathies. This is usually compensated for on the basis of loss of central visual acuity, ignoring the fact that depth perception is, in the first place, extra foveal and, in the second place, binocular depth perception is impaired. This is at variance with allowances for compensation for visual acuity loss in cases of media disturbances in which it is assumed that there is a corresponding loss in binocular stereoscopic acuity.

Since, as already mentioned, loss of binocular depth perception may parallel most defects in central visual acuity for distance due to media disturbances, it would seem logical to redefine loss of use of an eye in terms of loss of binocular depth perception or participation of an eye in the act of binocular vision. This, as we know, varies in the States between 20/100 visual acuity and 20/400 visual acuity. This should be a matter for review.

It would seem wise to attempt to standardize binocular depth perception acuity testing, not only in relation to the situations herein described, but also in relation to a redefinition of monocular blindness. This involves establishing: (1) The threshold of binocular stereoscopic acuity; (2) the point of abolition of binocular stereoscopic acuity from involvement of one eye; and (3) a scale of gradation between point one and point two.

Pre-employment eye examinations of industrial workers

The fundamental attack on the obvious inequity of "uncorrected" vision as the basis for compensation for eye injuries in my opinion, is the promotion of a standard and universally applied pre-employment eye examination. The goal of full employment, rehabilitation, and equitable distribution of compensation benefits among all workers makes pre-employment physical examinations a rational procedure.

At first glance it would appear that the administrators of workmen's compensation using "uncorrected" visual acuity as a basis would not be interested in pre-employment examinations, since the pre-existing state is ignored by them. It was surprising, therefore, to find that, of the two thirds of the States expressing themselves in favor of pre-employment examination, one half were States using "uncorrected" vision as a basis. The two thirds of the states in favor of pre-employment examinations were all in favor of the examinations being done by industry, except one, which stated that it is immaterial whether done by labor or industry. The minority of States that expressed misgivings of pre-employment examinations gave the following reasons: that the job done by industry is not adequate; that the subject is controversial and would meet with labor opposition; that it might cut down job opportunities; that it might be used to deduct pre-existing conditions from awards.

Obviously in the subconscious minds of

the administrators, the pre-employment examination had a medicolegal purpose. There are of course other important purposes of preemployment physical examinations—job placement (not merely selection of the fittest), the prevention of accidents by visually defective employees, increase of production, improvement of skills of workers, vocational guidance, the social goal of full employment, and betterment of labor-management relations.

The majority of the administrators, in response to the question whether they were in favor of having staff ophthalmologists (only two states have them), expressed themselves in favor of such a plan. The answers showed no relation to whether the State used "corrected" or "uncorrected" vision as a basis for compensation.

In four States the courts administer compensation. Impartial ophthalmologists are employed when the need occurs. One State answered that "they would rather have a topflight consultant's opinion than that of a staff man of lesser qualifications." However, in the state of New York, where staff ophthalmologists have been used for about 30 years, the soundness of the principle has been long recognized. Recently the New York State Supreme Court established a Medical Advisory Board to deal with the problem of impartiality of expert medical evidence in courts.

The high incidence of controversies in regard to eye injuries deserves special comment. It revolves around etiologic diagnosis rather than the determination of functional damage. Controveries vary with carrier, from 0 to 30 percent of all cases. Since two percent of the population have glaucoma, the cause of which is not known, and since two thirds of all the uveitides and optic neuropathies and maculopathies are etiologically not solved in our best clinics, and since one third of all cases of defective vision are classified as amblyopias, or weakness of sight without apparent cause in the ocular structures, the reason for controversies is clear.

The present status of pre-employment medical examination in the United States may be summarized as follows:

Fifty percent of the total labor force is enrolled in large industrial establishments (two-percent of all industries employing more than five hundred workers). These industries have large medical departments of their own for pre-employment examination as well as preventive and therapeutic services for their workers, and they have conspicuous medical achievements to their credit. Ninety-eight percent of the industrial plants (employing the other 50 percent of the labor force) are too small to provide medical services and, therefore, are not equipped to do pre-employment and periodic eye examinations.

It seems to me that a campaign for pre-employment eye examination by ophthalmologists would focus attention on the evils of "uncorrected" visual acuity as a basis for compensation and lead to legal reforms in the matter. In general, not only is the line of demarcation between the legal purposes and the public health purposes of pre-employment examination wearing thin, but there is a great deal of wasteful and unnecessary duplication in physical examinations which are now being conducted by many agencies besides industry.

Extension of occupational disease coverage makes pre-employment examination available to industry by the State of Oregon. Nonoccupational disability benefits, recently introduced in New York State and already in existence in a number of other States, provides for social or sickness insurance of industrial workers by funds made up by contributions from labor as well as management. Then there are the health and welfare funds of the labor unions, which have grown from 200 million dollars in 1948 to one and one-half billion dollars in 1953, and which provide for preventative as well as thera-

peutic health services to some 16 million unionized workers. Some 20 million veterans now in industry, have had physical examinations not only at induction but at discharge. Incidentally, many veterans frequently seek attention for industrial injuries at Veterans Administration facilities. There are also physical examinations of minors before they are issued working papers, and special eye examinations by motor vehicle license bureaus, by public schools, by civil service examiners, private health agencies, U. S. Employment Services, and for unemployment insurance benefits.

It would seem, in view of the multiplicity of eye examinations and the various purposes for which they are done, that standardization of eye examinations and the reporting of them could be worked out to the benefit of all concerned. Examination of the eyes should be done by ophthalmologists for the eye examinations given as part of a general physical examination by nonophthalmologists are inadequate and unreliable, even in hospitals.

Notes regarding Canada

The picture in Canada (data on seven Provinces) was obtained through the courtesy of Dr. Henri Pichette, the secretary of the committee. It is much more uniform than in the United States. Six of the Provinces have a chief medical officer who forwarded the data. None have, or think it necessary to have, staff ophthalmologists; they are satisfied with independent consulting ophthalmologists. Free choice of treating physician is provided for in all the Provinces.

In all the Provinces also the loss of use of an eye, defined as "no light perception," is awarded 16 percent of permanent total disability, while in the United States it varies between 10 percent and 50 percent; however, in the majority of the States it is 20 percent. For monocular aphakia all give 75 percent of award for loss of an eye, and for diplopia (presumably total) only 64 percent of the loss of an eye. There is only a cash settlement if loss of use amounts to less than 10 percent of permanent total disability; otherwise it is in the form of a pension for life. In the United States, it is a fixed schedule of so many weeks of compensation for loss of an eye.

Four Canadian Provinces use "corrected" as a basis, two allow for "uncorrected" and "corrected," but one believes it should be "uncorrected." Pre-employment examinations are favored in four of the Provinces. One of the four suggests that if it is not done by industry, it could be done by school medical services. Two have "no comments" in regard to pre-examination. Earning-power criterion is used for the allowance for the state of the uninjured eye in two Provinces, and one is not satisfied with the earning-power criterion. Concern in the malingering is manifested by two Provinces; no such spontaneous concern was elicited from the States.

Summary

A survey of the situation of workmen's compensation for ocular injuries in the United States discloses a disconcerting lack of uniformity due to the existence of 48 separate jurisdictions in the matter. Of the 46 States reporting, only eight use the American Medical Association committee's recommendations; 13 States use a modified method with a compromise between "corrected" and "uncorrected" visual acuity, and 25 states still use "uncorrected" visual acuity as a basis.

Comparing the present situation to that of 1940, it is evident that little progress has been made in obtaining acceptance by the State Workmen's Compensation Commissions of the A.M.A. committee's recommendations.

In view of the social nature of the compensation laws and the judicial interpretation of those laws, a concerted effort should

be made by ophthalmologists to call attention to the serious objections in compensating for minor eye damage at the expense of other industrial workers who have suffered serious eye damage. This results from the use of the "uncorrected" vision as a basis for compensation.

Attention is also called to the emphasis on central visual acuity for distance as the sole approach to eye damage, and to the problem, very often ignored, of disabilities due to impairment of binocular depth perception in eye injuries. It is suggested also that pre-employment eye examinations be extended and that a standard procedure of eye examination and recording be adopted, with examinations being made exclusively by ophthalmologists.

Veteran's Administration Center.

MENINGIOMAS: AN OPHTHALMIC PROBLEM*

Diagnosis and results of treatment

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Meningiomas of the suprasellar area are usually reported by the neurosurgeon but the ophthalmologist should bear the greatest load in their discovery. Meningiomas of this area include most of those which may be called olfactory groove, sphenoid wing, anterior, and posterior clinoid meningiomas, since any of these can extend to involve the optic nerve and chiasm. Indeed, in the larger tumors, it is often difficult to state exactly where the tumor did originate.

In two recent reports[1, 2] of meningiomas it was noted by the neurosurgeons that these tumors gave as few indications of their presence as any lesion of the central nervous system. This is particularly true of meningiomas in the suprasellar area.

The usual evidence of this tumor is stated to be a visual loss in one eye, slowly developing, together with a temporal field defect of the fellow eye.

In one of the recent series,[1] 66 percent of the patients had entirely lost the vision in one eye before the lesion was discovered.

The careful study of the visual field *routinely* in the ophthalmologist's office seems to be the key to early diagnosis and the prevention of severe visual loss.

Review of our cases emphasizes that these tumors are truly "occult" in most instances:

1. They are often confused with other conditions, and the early diagnosis is thereby delayed.

2. There were few signs or symptoms indicating serious brain disease.

3. Whenever ocular or neurologic evidence was present, it suggested other diseases than the meningiomas, usually inflammation, occasionally hysteria, or even aniseikonia.

4. Progress, if any, in the condition was extremely slow, until the vision was lost in one or both eyes.

5. The tumors were very large, often requiring bilateral cranial surgery, sometimes lobotomy and secondary surgical procedures. The neurosurgeons who operated were fortunate in having *no* mortality in this series.

6. Less than 10 percent of our series, or any other than I have found recorded, were cured with 20/20 vision in each eye.

7. It was usual to have repeatedly negative medical, neurologic, and X-ray studies. Air studies were often not diagnostic unless repeated. An electroencephalogram was usually not helpful.

8. While rarely seen in the private practice

* A revision of the paper presented in collaboration with B. B. Whitcomb, M.D., before the American Ophthalmological Society, Glacier Park, Montana, June 1954.

of ophthalmology, the responsibility for the diagnosis and suspicion of tumor rests most heavily on the ophthalmologist and his ability to perform and interpret visual fields.

9. The visual field diagnosis in 75 percent of our cases was a homonymous hemianopsia rather than a bitemporal or chiasmal defect.

If the ophthalmologist will study the visual fields for evidence of the meningiomas, he will be much more able to report his cases to the neurosurgeon before tragic loss of vision results. With this thought in mind, the visual field findings in four cases which we have found in our practice in the past six years are going to be emphasized.

The incidence of meningiomas is approximately 15 percent of all brain tumors.[4] We feel that the results were emphatically satisfactory in that each patient was rehabilitated. It is apparent, however, that the results will be improved by earlier recognition of the disease.

It should be stated that the suspicion of the diagnosis of meningiomas is an office procedure and should be accomplished in the ophthalmologist's office through field study. The literature reports that most of the tumors occur in females and in some cases are made worse by pregnancy, and that most of the patients develop the symptoms about their 45th year.

There is unanimous agreement that the initial symptom is loss of vision. Gibson[3] and Grant[1] have aptly stated that little reliance can be placed on the secondary indications of intracranial tumor, such as increased intracranial pressure, choked disc, or roentgenography. The ophthalmologist must be alert in order to make an early diagnosis from the visual field findings. If he uses a technician for visual field tests, the least abnormality must always be carefully investigated. It is preferable that the ophthalmologist do the visual fields himself. Even the neurologist's field studies should be viewed with skepticism. Cushing taught that a good visual field examination will often take two hours. Rucker has a similar opinion.

It is commonly noted that the progress of the symptoms in meningiomas is often *very* slow. Headache is sometimes mentioned as an early symptom in meningiomas of the suprasellar region, and from this we should deduce that all patients with headache seen by the ophthalmologist should have careful visual field studies. In other words, the more we know of meningiomas, the more we realize that routine visual field studies by a competent examiner are the surest method of finding the meningioma early.

In keeping with the fact that meningiomas are an occult form of intracranial tumor, it is to be noted that the general physical examination and also the neurologic examination in the majority of cases will not reveal any pathologic signs until late and critical stages. In 15 percent of the cases of meningioma, there will be a decrease in the sense of smell, usually unilateral but of little help. The earlier these cases are found through visual field examination, the more chance there is of overcoming the lesion without death or blindness.

In five of the 52 cases at the Mayo Clinic, the ophthalmoscopic examination was considered normal. Gibson mentions a mild optic atrophy as one of the earliest ophthalmic signs. In my experience the atrophy is often not a complete pallor of the disc but more a waxy-pink pallor—often nearly within the limits of normal. Skull X-ray films are usually negative, especially in early cases, and air studies or arteriography are usually required. Do not hesitate to urge these diagnostic tests if there is a reasonable suspicion of a meningioma.

Electro-encephalographic studies are sometimes suggestive but are frequently not diagnostic in my experience. Air-studies have often enough been deceptively normal to make them less reliable than a careful clinical examination of the visual field, and this in itself adds to the occult nature of these tumors. Arteriography has more promise as a diagnostic procedure; however, it is dangerous in sclerotic conditions.

One of the important findings on a lumbar puncture is an increase in protein of the spinal fluid, especially if the lesion is progressively increasing. When the protein is over 60 mg. percent, a meningioma should certainly be considered. In some of our cases the protein levels varied enough to support a diagnosis of inflammation. We deduced that the inflammatory process receded as the protein level decreased. A renewed rise in the protein level of the spinal fluid determined investigation by the neurosurgeon.

In Case 1, the visual field was the only test that consistently indicated a lesion; therefore, the ophthalmologist must be willing to urge surgical intervention when he is sure of his field study.

Case reports

Case 1

A 46-year-old woman complained of poor vision after she had seen several ophthalmologists. In addition to poor vision, she had noticed that she was not very sure of her footing on the street, and she had been having difficulty with pencil writing and reading a newspaper for about a year. She had no symptoms other than these and took no analgesics or sedatives.

She was first seen at a time when she was having a severe emotional upset. She had been living with a man and his young daughter for whom she was caring. As an unmarried couple they decided to separate. The patient in this case felt very deeply attached to the child and man, and there was some question in the minds of many of the examiners as to whether she was not having a hysterical episode.

Her visual fields were slightly contracted generally but showed an over-all right homonymous hemianopsia (figs. 1 and 2). This field was obtained only once, and repeating it the same day revealed a complete generalized contraction to less than 10 degrees. At this time there was a questionably waxy-pinkish pallor of the right disc. She was still able to read J1 type which is equal to 14/21 on the American Medical Association reading card even though she only admitted vision of 20/600 in the left eye and counting fingers in her right eye.

Visual fields were repeated frequently and, on each occasion, there was generalized contraction to all size test objectives to less than 10 degrees. However, occasionally, especially by using an object the size of the hand, a right homonymous hemianopsia could be

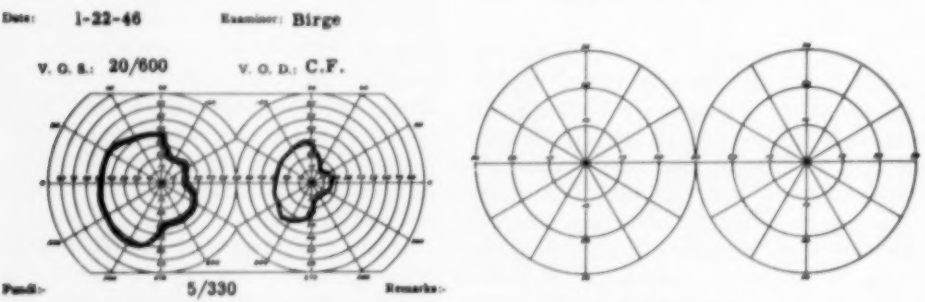

Fig. 1 (Birge). *Case 1.* Visual field in meningioma. One of the earlier fields. In this case organic changes were overlaid with hysterical findings.

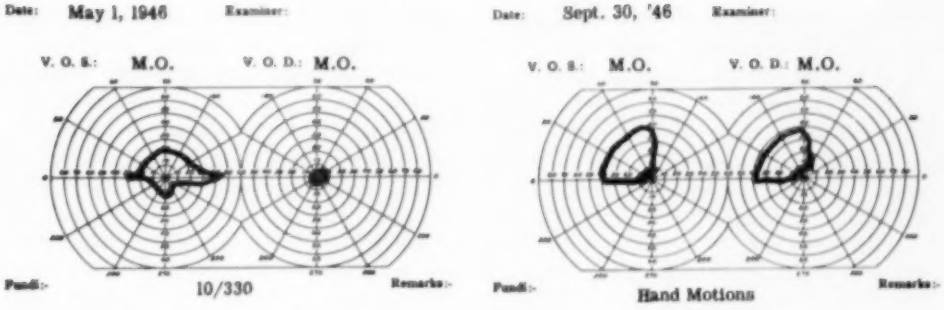

Fig. 2 (Birge). *Case I.* Visual field in meningioma. A later field—after the hysteria had improved and when there was marked evidence of organic visual failure.

suspected. Five months later, the visual field was approximately the same.

Here we had a problem of trying to unravel an organic defect from a superimposed hysteria. When there are two occult problems with which to cope, one a possible meningioma and the other a well-established hysteria, there is no more difficult case for the ophthalmologist, or any other physician.

To make the findings clear, let me repeat the initial, ophthalmologic description:

Pupils were dilated normally; chambers were of normal depth. The media were clear. Disc color appeared normal, although yellowish-pink on the right side. There was no cupping. The margins of the disc were flat and distinct. Capillaries around the discs were not dilated. The retinal veins were not enlarged. The maculas appeared normal. The periphery was clear.

The patient complained of continuing failure of vision although it was hard to measure because it was so reduced.

This patient was seen by several ophthalmologists in our city, together with examinations by some of our best medical men, neurologists, and neurosurgeons.

During her first hospitalization two months after the onset of these symptoms, she was apparently made worse as far as her hysteria was concerned. The diagnosis at that time, made by an elevated sedimentation rate of 32 mm. and repeated elevation of the spinal fluid protein, was arachnoiditis. She was seen by several neurologists, neurosurgeons, and psychiatrists.

The ophthalmologist, in referring the case, had stated:

"In referring this patient to you, the suspicious findings of an incongruous right homonymous hemianopsia had been considered upon several occasions. The lesion is, therefore, suggested to be in the superior and lateral regions of the left optic tract, approximately two mm. behind the chiasm. The greater pallor of the right disc, together with lesion in the left chiasmal region, is to be noted. I would suggest further consideration of a slowly expanding intracranial lesion, in spite of hysteria and the possibility of a diagnosis of an arachnoiditis."

The patient was discharged from the hospital with a diagnosis of hysterical amblyopia, homonymous hemianopsia, and arachnoiditis. Later a diagnosis of multiple sclerosis was made. The neurosurgeon did not trust the visual field diagnosis!

The encephalogram was entirely negative except for poor filling of the arachnoid spaces. The neurosurgeon did not believe that the slight possibility of a defect in the anterior frontal horns was of diagnostic significance, although he mentioned the possibility of midline meningioma. There was never any evidence of increased intracranial pressure.

When a case such as this puzzles an entire hospital staff, the patient is usually sent to another institution. This was accomplished, after the patient had recovered from her encephalopathic state. Reports from other and well-known institutions were equally negative and the patient was returned to us for whatever we could do for her.

During the ensuing months, the patient's vision first improved and then decreased. The hysteria remained the same. The pallor of the nerves seemed to increase although it could not be measured. The failing vision definitely increased to the point where telescopic spectacles were offered.

None of the neurosurgeons who had seen the case would consider a surgical intervention, until finally a consistently mounting spinal-fluid protein made the neurosurgeons willing to explore the cranium. When she was admitted for surgery she was practically blind and the visual field could only be determined by light projection.

Complete operative note on Case 1

Under intratracheal anesthesia, a coronal incision was made in the scalp and the anterior flap was reflected forward subperiosteally. A left frontal bone flap was then turned by means of four burr holes with a hinge on the temporalis muscle. The dura was reflected from the anterior orbital plate and it became quite adherent in the region of the cribriform plate and here the dura was opened.

A firm reddish tumor was immediately disclosed. Biopsy with frozen section revealed this to be a meningioma (fig. 3). As this tumor was further exposed, it was found to be very large, crossing the midline and extending well upward into the frontal lobes. The ventricles were tapped to give further decompression and the tumor capsule was opened and a considerable portion of the tumor removed by means of pituitary scoops and electric loops.

As more of the tumor was removed, however, and exposure thereby increased, it became evident that the extension into the right frontal region would require further exposure, whereupon a similar right frontal flap was turned, using the same anterior burr hole. The right frontal lobe was similarly raised and protected with cotton pledgets.

The tumor was then exposed on its anterior surface and found to extend as far on the right as it did on the left, being rather symmetrical in its extension. It was in contact with the falx cerebelli anteriorly and superiorly. To increase exposure further, the falx and longitudinal sinus were transected, permitting more adequate retraction of the frontal lobe.

As the tumor was gradually exposed and its intracapsular mass removed, it was found to be attached to both cribriform plates along both sphenoid ridges and clinoids. On the right side, it also extended over the sphenoid ridge into the middle fossa. A rather pro-

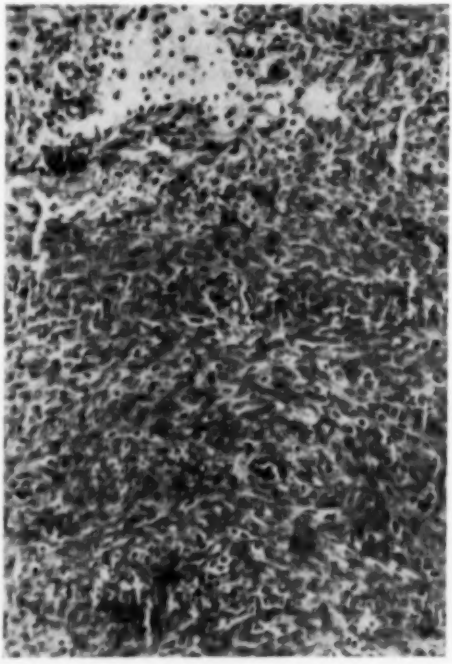

Fig. 3 (Birge). *Case 1.* Photomicrograph of tissue removed at operation.

longed and careful dissection and enucleation of the tumor was performed in the hope of preventing damage to the optic nerves and clinoid arteries.

As the mass of the tumor was decreased, its superior surface was readily separated from the cortex. The optic nerves were seen to be compressed into the form of a large horseshoe with marked thining of the chiasm. The distance from the clinoids to the chiasm was tremendously lengthened, the chiasm being pushed up to an unbelievable height. The carotid arteries appeared to lie well medial to the curve of the stretched optic nerves. The diameter of the optic nerves, however, after the tumor was removed, did not appear unduly small.

The tumor was removed from its attachment to the dura along both sphenoidal ridges and the right sphenoidal ridge was partially removed in its midportion in order to expose that portion of the tumor which extended into the middle fossa and permit its removal. Because of its extensive sphenoidal attachment and the large exposure, it was felt unwise to remove all of the dura for fear of permitting infection through the cribriform plate. This dura, however, was thoroughly fulgurated over all the regions of the tumor attachment except in the region of the optic nerves for fear of injuring these structures. The frontal lobes, the inferior surface of which were moderately contused by the procedure, were then exposed.

Hemostasis was obtained and the wound thoroughly irrigated. There was moderate hemorrhage from the tumor during its removal, and over the prolonged operating the patient was given five transfusions.

The dura was not closed completely on the right but was closed on the left. It was then attached to the periosteum about the margins of both bony exposures and bone dust was placed in the anterior burr holes for cosmetic reasons.

Gelfoam was placed over the cribriform plates. The bone flaps were wired into position and the wound was closed in the usual manner with two layers of interrupted zytor. The patient withstood the procedure well.

This patient made a satisfactory recovery and has been followed for eight years. She is successfully managing a home, now married and living happily and taking full charge of her home without the use of telescopic spectacles or other aids, although her central visual acuity is counting fingers only. No doubt there is a certain amount of euphoria due to the damage to her frontal lobes.

Comment. This case indicates that meningiomas are difficult for the ophthalmologist, for more reasons than one. In the first place, all symptoms can be completely overlaid or masked by hysterical findings. In the second place, the progress of such a lesion, as was present in this patient, must be estimated by the ophthalmologist; yet the neurosurgeon may be loath to explore for the lesion.

Although this may be considered a successful outcome, the physician realizes that earlier diagnosis would have given a better result. The patient is alive and is living happily but, of course, her vision is markedly reduced. On the last examination this year, her vision was recorded as: R.E., no light perception; L.E., best correction with glasses, 20/300; with an add of +6.0D.sph. = 14/56 or 58.5 percent near vision according to the American Medical Association reading chart.

Not only must the ophthalmologist be well versed in performing and interpreting visual fields, but he must be willing to make a localizing diagnosis from his findings, and he must tenaciously work toward the proper surgical treatment of his case. Some of my colleagues may feel that calling a case like this "occult" is an understatement.

Case 2

This man, aged 45 years, was admitted to the hospital complaining of fatigue, after a day's work, for two years. Two months previously, the patient noticed weakness and fatigue to the point where he had to stay

home from work. A week later, the patient had failing vision and within two weeks was unable to read or write. Also, the patient had weakness on getting out of bed and had shaking chills. The basal metabolism rate was −37 percent. He had had a shaking chill every other day since the onset, with vomiting occasionally. Two weeks previously, he had intermittent loss of vision. There were no headaches or loss of taste or smell.

The patient had severe papilledema with hemorrhages in both retinas and a left homonymous hemianopsia, and he complained of visual hallucinations. He saw "pinwheels" in left visual field. The impression was a right temporal lobe lesion. He was admitted for air-studies directly from the neurosurgeon's office.

A ventriculogram was done June 20, 1953, and showed no filling of the frontal horns. He was then operated upon through the right frontal flap and a large olfactory-groove meningioma was found resting on the dorsum sellae and running along both sphenoid wings. There was difficulty controlling the bleeding. An anterior lobectomy was necessary to get at the tumor which was only partially removed. Obviously such an extensive operation was followed by a stormy convalescence.

The patient finally returned to a normal mental condition and removal of the remaining tumor was considered necessary on December 11, 1953. He was re-operated through a left frontal-temporal incision and the residual tumor was removed from the olfactory groove. A few adhesions around the chiasm were removed. For rehabilitation he was then referred to me. When telescopic spectacles were fitted, the patient was able to resume a desk position, and is now happily re-employed (figs. 4 and 5).

Sections of the tumor were made up of large cells with indistinct bodies arranged in nests. Whorls were present, together with fibroplastic elements between the whorls. Psammoma bodies were present.

It is to be noted that this patient did not see an ophthalmologist *before* the surgery. Could an ophthalmic consulation in the early stages of this disease have aided the neurosurgeon in localizing the lesion more accurately?

His final vision was: R.E., +1.0D. sph., 20/200; ×2.2 magnification, 20/100; add, +12.0D. sph., 14/28; add, +6.0D. sph., 14/81. L.E., counting fingers (no correction).

Case 3

This 45-year-old woman was operated on in 1953. She came to my office complaining of presbyopia and stated that she had lost the vision in her left eye eight months previously due to an infection for which she

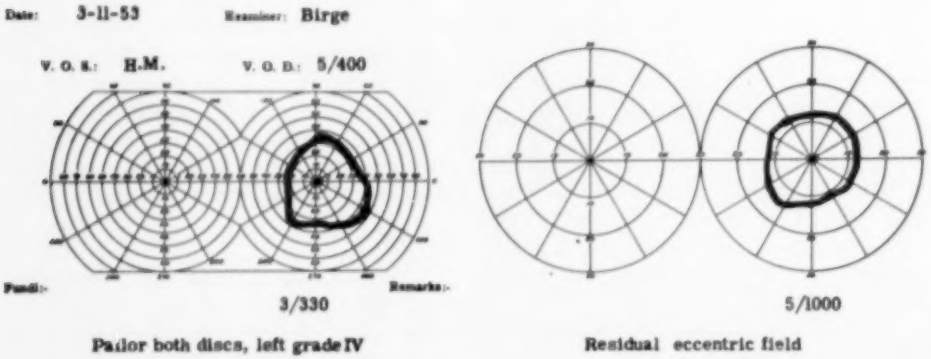

Fig. 4 (Birge). *Case 2.* A postoperative visual field in meningioma.

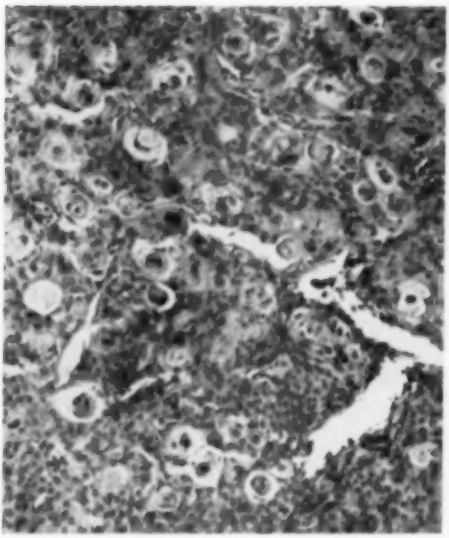

Fig. 5 (Birge). *Case 2.* Photomicrograph of tumor.

had received numerous penicillin injections. Her chief complaint was seeing lines in front of both right and left eyes as though hair were hanging in front of her face: This persisted even after the therapy just described.

The first visual field (fig. 6) examination revealed a temporal hemianopsia in the left eye but I was suspicious that it might be progressive in her case (as it was). Three months later, the visual field examination revealed a complete temporal hemianopsia in the left eye and an early temporal defect in the right eye, with very small test objects. The patient was referred to the hospital where an encephalogram and air-studies of the ventricles were performed. X-ray studies were negative but spinal fluid protein was elevated to 59 mg. percent, 2+ Pandy.

A pneumo-encephalogram was first thought to be normal but, on review, showed evidence of pressure against antero-inferior aspect of the anterior horns of both lateral ventricles. These findings were consistent with a mass lesion in the midline near the tuberculum sellae.

X-ray studies of the skull were normal. Electro-encephalography did not permit any diagnosis.

The neurosurgeon's diagnosis was meningioma which was found at operation and successfully removed. The pathologic (fig. 7) report showed a type of meningioma consisting of masses of spindle-shaped cells arranged in solid cords and alveoli with definite whorl formation and calcification with psammoma bodies.

Her vision remains at 20/25 in her right eye; her left eye, in which there is a slight pallor of the optic nerve shows a large scotoma.

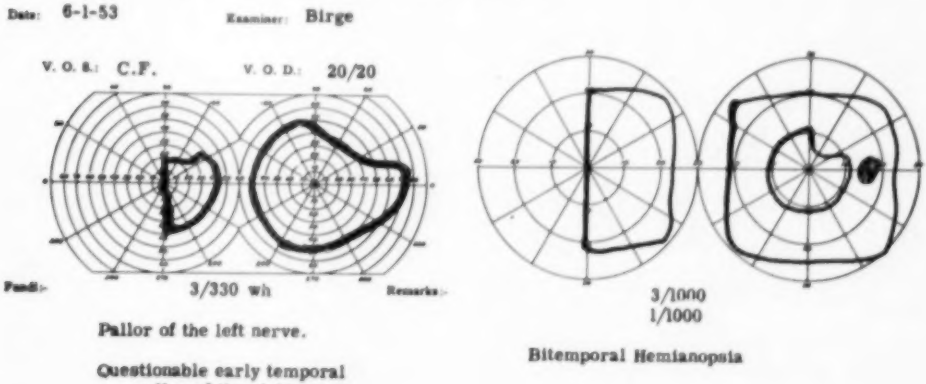

Fig. 6 (Birge). *Case 3.* Visual field in meningioma, showing evidence of bitemporal hemianopsia.

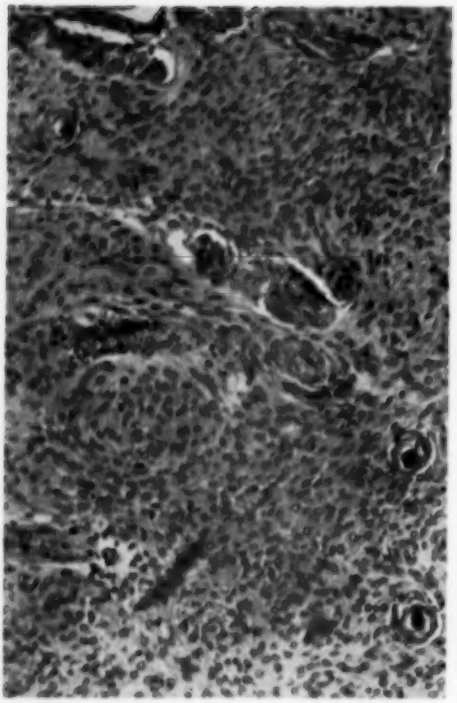

Fig. 7 (Birge). *Case 3.* Section of tumor tissue.

This patient illustrates some of the difficult possibilities in the diagnosis of meningiomas, such as a previous diagnosis of inflammation of the left optic nerve and negative X-ray findings. The diagnosis in this case was made early, but not early enough, and was based upon air-studies of the ventricles, after the visual fields showed a chiasmal lesion.

CASE 4

The most recent and perhaps the most successful case of occult meningiomas is recorded as follows:

This 51-year-old woman came to the office for an aniseikonic examination. She had all the symptoms of aniseikonia, mainly that she was car sick and, after using her eyes a lot, she became nauseated. She was nervously upset by traffic and she had had trouble getting satisfactory glasses. Her physician referred her for an aniseikonic examination.

She had been examined in many of the large Eastern cities without any diagnosis being made, other than nervous tension.

Her vision was 20/25 when examined and her visual fields were described as within normal limits by the first examiner. A careful recheck of the visual field revealed a right homonymous hemianopsia. Ophthalmoscopically, there was more pallor noted in the left nervehead than in the right, and the veins in the left retina were fuller than in the right retina. The patient had a faint tremor on the left side of her face, and a minor amount of adiadochokinesia of the left hand. She had also a poor finger-to-nose test with the left hand and she complained of photophobia for the past year.

Incidentally, she showed less than 0.25 percent of aniseikonia.

I felt so positive that she had a meningioma that I made the diagnosis on the first day and referred her to the medical man who had sent her in for investigation, and she was operated upon.

Notes from the hospital record. The neurosurgeon described this as a most complicated brain tumor. The patient had been hospitalized without diagnosis for two months prior to the time my diagnosis of tumor was made. When she was sent in with a diagnosis, the electro-encephalogram findings were said to show progressive changes. Skull films were negative. Neurologic examination was negative. Spinal puncture was normal. A pneumoencephalogram showed elevation of the right frontal horn. An angiogram in the right carotid showed a vascular tumor in the right sphenoid ridge. This was done on the basis of visual fields.

On the basis of my visual field, the tumor should have been located behind the chiasm on the left. There was also greater pallor of the left optic nerve. The neurosurgeon performed a right craniotomy and uncovered a huge meningioma extending into the frontal fossa and anterior portion of the temporal fossa. It was removed with great difficulty.

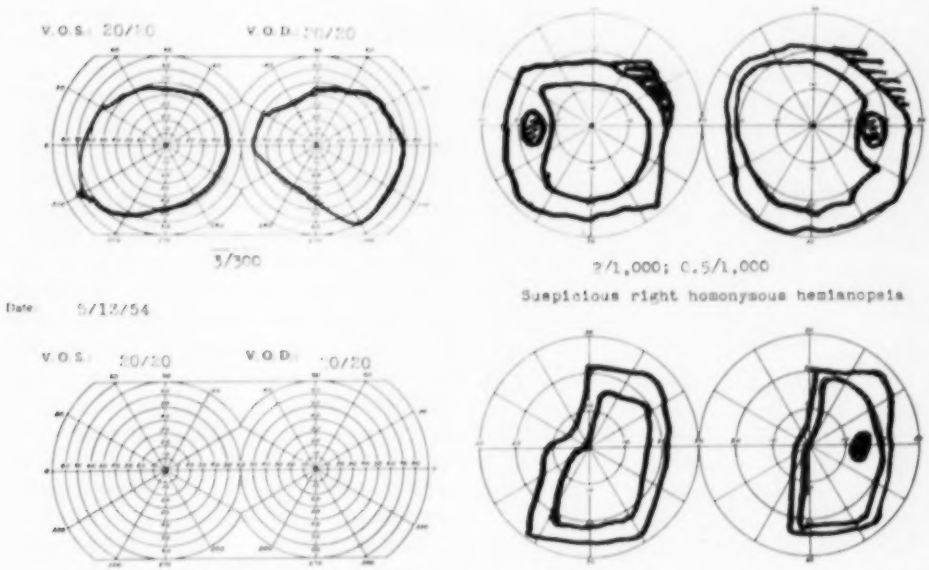

Fig. 8 (Birge). *Case 4.* Visual field in meningioma. An early right homonymous hemianopsia gave the first positive evidence of a brain tumor. The left homonymous hemianopsia is the postoperative visual field.

It was very vascular and surrounded with malignant edema of the brain.

The postoperative course was very serious. Tracheotomy was performed on the second day. Diabetes insipidus developed. The patient remained stuporous for five days. The diagnosis of herniation of the hippocampus was made on the fifth day and, at this time, a radical inferior temporal lobectomy and hippocampectomy were performed. Following this, improvement was slow but progressive. The patient became conscious one week after the second operation.

She was able to be in a chair on her third week after operation. As she recovered, she showed no signs of her former severe anxiety.

She was re-examined in the office three months after her operation and, at that time, had 20/25 vision in each eye with a residual quadrant left homonymous hemianopsia. Her greatest trouble being diplopia, she was given vertical prisms which controlled it.

Three months later she was examined again and at this time was found to have no further diplopia. Her only disability following this serious brain surgery had finally disappeared.

The patient appeared in excellent spirits and was physically apparently quite healthy. The vision in each eye was 20/20 and she was using, with satisfaction, the same glasses which had been prescribed for her six months before the tumor was diagnosed.

It is apparent from the fact that the tumor was found to be mainly in the right sphenoidal area that the visual field findings were caused by pressure—the tumor pressing the chiasm backward so that the pressure on the chiasm and optic tracts was in the area of the left side of the brain, thus causing a slight right homonymous hemianopsia.

The removal of this tumor damaged the visual tract sufficiently to leave the patient with a left homonymous hemianopsia, which, however, is not seriously bothering her.

Summary

The difficulty of diagnosis and treatment of meningiomas is illustrated by these case reports. Too often cases of meningioma are confused with old inflammatory lesions because of the relatively slow progress of the intracranial growth. In order to diagnose meningiomas early, a careful visual field is the first requirement. This should be followed by air-studies, an estimation of the spinal-fluid protein, and, possibly, angiography for the simplest confirmation of the diagnosis.

Not only are meningiomas confused with inflammatory lesions and demyelinating lesions but the stresses and strains of life provide emotional factors which may mask whatever findings suggest the presence of a meningioma in the suprasellar region.

It is well for those who are dealing with meningiomas to know that unilateral loss of vision may be the first sign, and that meningiomas frequently occur around the age of 45 years, and that women are more frequently affected than men. However, these facts do not make a diagnosis. A careful routine study of the visual field by a competent physician in every case of visual failure is the basic method of discovering the suprasellar meningioma.

In conclusion, I feel that the first and most important step in the diagnosis of suprasellar meningiomas is made in the office of the ophthalmologist. His ability to differentiate the true facts from the false will determine how many correct diagnoses of suprasellar meningiomas are made. X-ray studies of the skull, air-studies, and clinical course have all proven unreliable in certain instances.

Study your visual fields and be willing to urge the neurosurgeon to explore, when you are sure of your findings.

Investigate all cases of visual loss; many meningiomas are disguised under the heading of arachnoiditis or optic atrophy.

661 Farmington Avenue (5).

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Ophthalmic Miniature

> The rustic labourer eats what he can get; no aliment can hurt him: but the same food, if used by a sedentary person, whose head and eyes are always occupied in his employment, will soon be found to have a morbid effect. If, added to this, the latter should indulge in spirituous liquors, he will sooner perceive a diminution of his visual faculty, accompanied with a constant flux of humours towards the head.
>
> H. Colburn, London, 1816,
>
> *The Art of Preserving the Sight Unimpaired to an Extreme Old Age.*

OPHTHALMIC USE OF TERRAMYCIN AND HYDROCORTISONE*

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This paper is an attempt to evaluate the topical use of terramycin and hydrocortisone, employed singly and in combination, in the therapy of 73 patients with external and anterior-segment ocular diseases.

Nelson, et al.[1] have demonstrated that, when the adrenal cortex is stimulated, the principal corticoid secreted is hydrocortisone, and Dougherty[2] has shown that this natural adrenal steroid produces its anti-inflammatory actions at the tissue level.

Leopold[3] states that the action of the adrenal corticoids is not dependent on any systemic absorption but is purely a local phenomenon. It is also known that hydrocortisone, topically applied, has a therapeutic effect equal or superior to the parenterally administered form of this steroid. Further, Steffensen et al.,[4] using topical hydrocortisone in 12 patients with iritis, corneal ulcers, vernal conjunctivitis, phlyctenulosis, and syphilitic interstitial keratitis obtained superior results than with cortisone.

A recent study by McDonald, et al.,[5] also confirmed the fact that the anti-inflammatory effect of hydrocortisone was greater than that of cortisone; this same study failed to uncover an instance in which cortisone was effective and hydrocortisone was not. In fact, 18 patients were successfully treated with hydrocortisone who had not been controlled on ophthalmic cortisone therapy.

Again, Gordon[6] in a recent comprehensive survey concluded that topical hydrocortisone is superior to cortisone when compared in similar conditions. In short, hydrocortisone is a proved agent which protects the ocular tissues from the deleterious actions of allergic, bacterial, and physical agents by preventing or minimizing the usual inflammatory response with its undesirable sequelae.

Terramycin is a broad spectrum antibiotic which is bacteriostatic and bacteriocidal against a wide range of pathogens.[7] It has a negligible incidence of toxic and hypersensitivity reactions when used topically. Douvas, et al.[8] noted no sensitization or irritation from the local application of terramycin in the eyes of over 60 patients.

Polymyxin-B sulfate additively complements the antibacterial action of terramycin because this drug is strongly bacteriocidal for such notoriously therapy-resistant bacteria as Pseudomonas aeruginosa (Bacillus pyocyaneus). This antibiotic also has practically no toxic or sensitizing properties when employed topically.

In this study the four preparations used were composed as follows: (a) Terramycin-polymyxin ointment containing 5.0 mg. of terramycin and 10,000 units of polymyxin-B sulfate per gm. of white petrolatum base; (b) hydrocortisone ointment (2.5 percent) containing 25 mg. per gm. in white petrolatum; (c) terramycin-hydrocortisone ophthalmic suspension which was a liquid preparation composed of 5.0 mg. of terramycin and 15 mg. of hydrocortisone per cc. in mineral oil; and (d) terramycin-hydrocortisone ointment which was a petrolatum base containing 5.0 mg. of terramycin and 15 mg. of hydrocortisone per gm. No lanolin or methyl-cellulose preparations were used.

MATERIALS AND METHODS

For the purposes of this report the cases to be presented are divided into four groups

* The four ophthalmic preparations used in this study were supplied through the courtesy of Dr. M. Carlozzi of Chas. Pfizer & Co., Inc. Three of the preparations are commercially available: Terramycin Hydrochloride Ophthalmic Ointment with Polymyxin-B Sulphate, Cortril Acetate Ophthalmic Ointment (brand of hydrocortisone acetate ophthalmic ointment), and Cortril Acetate Ophthalmic Suspension with Terramycin Hydrochloride. The fourth, a combination of terramycin hydrochloride and hydrocortisone acetate in an ointment base, is under clinical investigation.

over a four-week period—depending on which of the four preparations described above was used in treatment.

Terramycin-polymyxin ointment. This preparation was used in the treatment of 23 patients with infections of the external ocular tissues or with superficial traumatic injuries likely to become infected. Ophthalmic preparations containing hydrocortisone were not available at the time these patients were treated. Had they been available, preparations combining hydrocortisone and antibiotic would have been preferred in most cases. Appropriate debridement and surgical drainage of abscesses were carried out, where indicated, in addition to application of the antibiotic ointment.

Hydrocortisone ointment. This preparation, applied four times daily into the conjunctival sac (or daily on dressing change in patients requiring dressings), was used in the treatment of 11 patients. The conditions treated were allergic inflammatory disorders not likely to be complicated by secondary infection.

Terramycin-hydrocortisone suspension. This preparation was used in the treatment of eight patients, most of whom had traumatic or irritative inflammatory lesions already infected or likely to be complicated by infection. The suspension is particularly well suited for daytime use by patients not requiring a dressing. It was effectively used over a period of two or three months by three patients.

Terramycin-hydrocortisone ointment. This preparation was used in the treatment of 32 patients having superficial ophthalmic infections or external injuries likely to be infected. The consistency of ointments makes them best suited for bedtime application, to remain in the eye through the night, and for use under dressings.

Results

The accompanying tables tabulate the results obtained in the 73 patients making up the four groups described above. Data in the tables point out that debridement, where indicated, preceded topical use of the preparations under study. Concomitant measures used in a few cases are also described.

TABLE 1

Results with terramycin-polymyxin ointment in 23 patients

Condition	No. of Cases	Results	
		Successful	Failures
Lid abscesses	7	6	1
Corneal foreign bodies	6	6	—
Corneal abrasion or laceration	3	3	—
Corneal burn	1	1	—
Acute suppurative conjunctivitis	3	3	—
Postoperative (strabismus)	2	2	—
Chronic conjunctivitis due to conjunctival chalazions	1	—	1

Results are listed as "successful" when the inflammatory phenomena disappeared promptly after the beginning of therapy, usually within 48 hours. In a few cases of chronic irritative lesions, treatment was continued for two to four weeks or longer to insure against relapse.

In only two of 23 cases did terramycin-polymyxin ointment fail to provide prompt relief of inflammation associated with infection. In these cases the infection was probably too deep to be affected by the topical application of antibiotics.

Hydrocortisone ointment promptly re-

TABLE 2

Results with hydrocortisone ointment in 11 patients

Condition	No. of Cases	Results	
		Successful	Failures
Lid allergies (reactions to mascara, shampoo, penicillin, tetanus antitoxin)	5	5	—
To prevent phacoanaphylaxis following needling of secondary cataractal membranes	3	3	—
To prevent reaction to chromic sutures following squint operations	3	—	3

TABLE 3

RESULTS WITH TERRAMYCIN-HYDROCORTISONE SUSPENSION IN EIGHT PATIENTS

Condition	Administration	Results	
		Successful	Failures
Corneal dystrophy (epithelial)	Instilled at bedtime	x	
Multiple chalazions, recurrent	Instilled four times daily	x (no new lesions)	
Corneal foreign body (steel sliver)	Used under dressing after removal of sliver	x (no infection or scarring)	
Corneal abrasion	Under pressure dressing for 48 hours after debridement; then four times daily	x (no infection or scarring)	
Ultraviolet burns of both corneas	Under pressure dressing for 48 hours after keratectomy	x (no infection or scarring)	
Exposure keratitis (due to facial nerve paralysis)	Instilled at bedtime	x	
Corneal burns (flash)	Terramycin-hydrocortisone ointment was used under patch for 48 hours after debridement; then suspension was instilled twice daily for five days.	x	
Marginal blepharitis (probably due to evaporation of tears—in patient with severe parkinsonism and poor blink reflex)	Instilled four times daily for two days		x (burned & increased redness)

TABLE 4

RESULTS WITH TERRAMYCIN-HYDROCORTISONE OINTMENT IN 32 PATIENTS

Condition	No. of Cases	Administration	Results	
			Successful	Failures
Corneal burns (flash)	1	Under patch for 48 hours after debridement; then suspension used twice daily for five days	1	
Urticaria of lids	1	Four times daily for three days	1	
Marginal blepharitis	2	Four times daily for three weeks in 1 case; at bedtime daily in other	2	
Recurrent sties	1	Four times daily for four weeks	1	
Chalazions, abscessed	5	Four times daily for 3 to 14 days; used on postoperative dressing in 2 cases	2 (postop.)	3 (required surgery or ruptured spontaneously)
Dendritic ulcer, recurrent	1	Hourly for 15 days (plus heat, atropine, intravenous typhoid H. antigen)	1	
Corneal lacerations	2	After debridement, four times daily for three weeks in 1 case, and under patch every two days for four days in other	2 (small scar remains in 1 case)	
Conjunctival laceration	1	After suture, under patch, 1 every two days for seven days; then four times daily		
Corneal foreign bodies (ulceration in 2 cases)	7	Postoperatively on dressing for 48 hours; then four times daily for three to five days	7	
Iritis, acute	2	Every two or three hours for four days in 1 case, 20 days in other (plus heat, atropine, cortisone by mouth, and intravenous typhoid H antigen)	2	
Conjunctivitis, chronic	4	Four times daily for 4 to 15 days	4	
Conjunctivitis, angular	1	Four times daily for two days	1	
Conjunctivitis, acute suppurative	2	Every two hours for four or five days	2	
Postoperative (cataract extraction)	2	Four times daily for 7 to 14 days	2	

lieved five patients with lid allergies, and the phacoanaphylaxis sometimes seen following repeated needling of secondary cataractal membranes was not observed in three patients using hydrocortisone ointment prophylactically. In three patients, the ointment failed to prevent reactions to chromic sutures following squint operations. It is possible that topical hydrocortisone does not penetrate deeply enough to have an effect in these cases. Trial of systemic hydrocortisone for this purpose would seem warranted.

The only failure of terramycin-hydrocortisone suspension was in a case of marginal blepharitis in a patient with severe parkinsonism and a poor blink reflex. The resultant rapid evaporation of tears probably was responsible for the irritation produced by the medication in this case.

In the table showing results with terramycin-hydrocortisone ointment, three cases of abscessed chalazions are listed as failures. However, it is probable that topical terramycin does not penetrate deeply enough to affect such infections and that absorption of the abscesses could not be expected.

It would seem that in eight of the 73 patients treated the infections or inflammatory process was too deep to be affected by topical therapy. Of the remaining 65, only one can be counted a therapeutic failure—and this was also the only patient experiencing an adverse reaction (the patient with parkinsonism, mentioned above, whose eyes were irritated by medication).

Summary and Conclusions

This report presents experience with terramycin and hydrocortisone, used either singly or combined, in the topical therapy of 73 patients with inflammatory diseases of the external ocular tissues and of the anterior segment of the eye. Failure occurred in only one case in which there was presumable adequate penetration of the medicament needed to combat the inflammatory process, and the only instance of local irritation from topical medication occurred in this same case. The following general impressions are drawn from the results obtained in this study:

1. Terramycin-polymyxin ophthalmic ointment is highly effective in the treatment of superficial ocular infections and in the prevention of infection secondary to ocular trauma. The presence of polymyxin in the preparation complements the broad-spectrum activity of terramycin by affording protection against Pseudomonas aeruginosa. Concomitant use of topical hydrocortisone is probably desirable in many cases in which this antibiotic preparation is indicated.

2. Hydrocortisone ophthalmic ointment is useful in a variety of allergic and nonspecific inflammatory diseases affecting the external ocular tissues and the anterior segment of the eye. It does not prevent postoperative tissue reaction to chromic suture material, deeply placed, or in the conjunctiva.

3. Terramycin-hydrocortisone ophthalmic suspension combines the advantages of its two components and is thus especially useful in inflammatory diseases caused by infection and in those likely to be complicated by infection. This preparation is well suited for daytime use by patients not requiring an eye dressing. A contraindication to the use of this oily preparation is the presence of a fistulous opening into the anterior chamber.

4. Terramycin-hydrocortisone ophthalmic ointment offers the same therapeutic activities as the foregoing preparation. It is particularly suited for bedtime application, to remain in the eye through the night, and for use under dressings.

131 Fulton Avenue.

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A SIMPLE PREPLACED SCLEROCORNEAL SUTURE*

With analysis of results

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The closure of cataract wounds by suture was described as early as 1867,[1] but it was not until 1894[2] and the enthusiasm of Kalt that this procedure achieved any popularity. Since that time many reports have appeared in the literature concerning the type and method of suturing and no unanimity of opinion exists as to the best method of wound closure. This means no one method is without shortcomings and each essayist feels that he can offer improvements. This presentation is to describe a method of wound closure which has many advantages, and a few disadvantages, but which on the whole has worked out extremely well in my hands over the past three years.

This method is based on certain concepts concerning wound closure and suture materials.

The first of these is the reapproximation of the tissues accurately to assure watertight closure. Therefore, some type of preplaced sclerocorneal suture is required.

Second, the use of a limbal based flap to afford a layer of tissue covering for the section was considered obligatory. The danger of epithelization and cyst formation in the anterior chamber may be small but nevertheless quite real.[3]

Third, the amount of tissue reaction and vascularization seen with absorbable suture makes this material undesirable. Despite Dunnington's recent conclusion that mildly chromicized catgut is satisfactory,[4] this suture is more difficult to handle and cannot be tied as securely as a multiple filament material such as silk. On the basis of observations made with Maumenee several years ago on interlamellar corneal implants, there was little doubt that silk caused less reaction than catgut.[7] This technique of wound closure is designed for silk suture material.

Two years ago Alvis and Alvis described a method of wound closure which employed a preplaced mattress suture and two corneoscleral sutures.[8] Although their method could be employed wih a fornix-based flap, it was used largely without a flap. Furthermore, in their method three tissues were included in the one suture—conjunctiva, sclera, and cornea. In the following method only the sclera and cornea are united and the conjunctiva is closed separately as a covering layer.

The method

The operative technique described here has something in common with the methods described by McLean,[6] and Alvis and Alvis[8] (figs. 1 through 6).

1. The eye is fixed with forceps below and a superior rectus bridle suture above.

* From the Departments of Ophthalmology of the Wesson Memorial Hospital, Springfield, Massachusetts, and the Cooley Dickenson Hospital, Northampton, Massachusetts. Presented at the 13th clinical meeting of the Wilmer Residents Association, 1954.

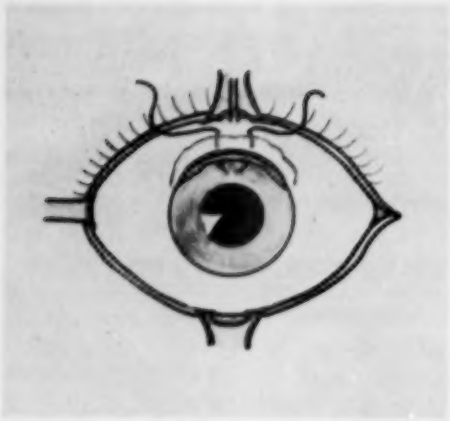

Fig. 1 (Bick). After a corneal hinged flap has been turned down and a corneoscleral groove made, a double-armed suture is introduced across the groove from the sclera to the cornea, at the 11:30- to 12:30-o'clock positions.

Fig. 2 (Bick). The suture is drawn through the groove.

2. A corneal hinged conjunctival flap two to three-mm. wide is turned down from the 10- to 2-o'clock positions.

3. After the episclera has been cleared of tissue remnants, a 0.5-mm. groove is made with a No. 44 DeBakey blade into the cornea at the root of the flap extending from the 11- to 1-o'clock positions. In this manner one automatically obtains a bevelled closure.

4. One needle of a double-armed suture is passed at the 12:30-o'clock position into the sclera two-mm. above the groove to emerge in clear cornea two-mm. below. The needle is directed toward the center of the cornea. The second needle is placed similarly in the 11:30-o'clock position. The suture is passed just under the episclera to provide a firm bite.

Fig. 3 (Bick). Cross-section view, showing position of the suture.

Fig. 4 (Bick). The limbs transversing the groove are looped to each side.

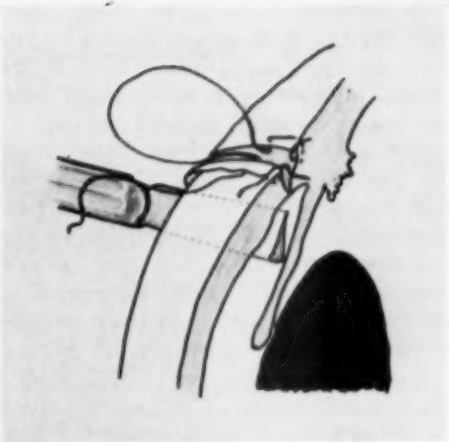

Fig. 5 (Bick). The cataract knife is introduced into the chamber and section is made between the suture limbs that have been looped aside.

Fig. 6 (Bick). The preplaced suture is tied with a surgeon's knot and the conjunctival flap is sutured as a separate layer.

5. The two limbs of suture traversing the groove are looped to each side and section is accomplished by either knife or keratome cutting between the suture limbs. This maneuver can be simplified by securing the loops that rest on the cornea with a smooth forceps and pulling downward, spreading the lips of the groove as the cutting instrument passes through.

6. The wound can then be enlarged with scissors if necessary and the iridotomy or iridectomy accomplished.

7. After extraction of the lens the wound may be closed rapidly by pulling up on the two corneal ends. A square surgeon's knot is then tied firmly to the point where corneal wrinkling is barely visible.

8. The conjunctival flap is sutured back as a separate layer.

Details of technique

There are some details in technique which should be mentioned because these affect the success of the method.

The needles which have proved most satisfactory are those manufactured by Grieshaber. The sutures are prepared at least 24 hours in advance. Since Grieshaber's needles become dull with boiling or autoclaving, some method of cold sterilization was required. A solution of methyldodecylbenzyl trimethyl ammonium chloride (C.R.I. germicide) 0.0175 percent was found to produce no corrosion of the needles even after three months' immersion.

The needles are threaded on each end of a 12-inch strand of black braided silk 6-0 U.S.P. (Deknatel) and are secured with a single knot about the needle eye. The sutures are placed in a rubber stoppered ampule and are soaked for at least 24 hours. The ampules themselves are sterilized by soaking in 70-percent alcohol for at least 20 minutes prior to opening. After removal from the C.R.I. solution the sutures are rinsed in sterile saline and are then ready for use. Sutures prepared in this manner have proved to be sterile on three separate investigations. Commercially available atraumatic, double-armed 6-0 silk sutures have been used satisfactorily but the quality of these needles is not uniform.

The DeBakey No. 44 blade, manufactured by Beaver, is especially useful for making the corneal groove. The blade is rounded which makes cutting on a curved surface quite simple. There is little danger of perforating the anterior chamber and the

depth of the groove is easily controlled. The blades are disposable and inexpensive. A new blade should be used for each case.

In making the groove, the conjunctiva should be stripped down to its insertion at the limbus as far as possible. The groove can then be placed in clear cornea and few blood vessels need be traversed. The low incidence of postoperative hyphema in this series was felt to be due to this precaution.

Castroviejo's curved corneal scissors were found to be of great assistance in extending the wound and superior to his straight corneal scissors or any type Stevens scissor employed for the same purpose. Since they follow the curve of the limbus only one or two snips are required to reach the horizontal meridian. The extension of the wound was performed as far forward as possible beneath the flap. By holding the scissors horizontally bevelling of the extended wound was automatically obtained.

Cauterization of superficial blood vessels in the region of the suture location was routine.

If the suture is not firmly anchored beneath the episclera, wound separation may occur. In one case in this series such a separation with iris prolapse had to be repaired on the third day. At operation it was found that one episcleral track was insufficiently buried and was hanging on one or two tissue fibers. Since this experience the episcleral bite has been checked carefully in each case and no further wound separation has occurred.

If the suture is placed too deeply, some difficulty may be encountered in removing it. One may have to use some tension on the suture. In two cases in this series difficulty in drawing the suture through the track resulted in hyphema. In one of these, there was an iris incarceration. Ordinarily the suture need not be removed before the 14th postoperative day. If the suture resists the tug of the forceps, it should be left for two or three days. Usually it can be withdrawn without resistance on the second attempt.

Results

For purposes of comparison, two groups of cases are considered. In one there are 67 cases where two corneoscleral sutures of the McLean type were employed with a corneal hinged flap. In the second are 96 cases of closure with a preplaced sclerocorneal mattress suture and a corneal hinged flap.

In Table 1 are represented the cases of wound failure. In approximately 10 percent in both groups there was some indication of wound failure. In three cases (4.5 percent) in the corneoscleral suture group was operative intervention required. In two cases (2.0 percent) with the McLean type sutures surgical correction was employed. It is interesting to note that no air injections were required to reform the anterior chamber in the mattress suture group, while it was needed twice in those employing the McLean type suture. This was thought to be due to a tendency for fistulization to occur around

TABLE 1

Types of wound failure

Method of Closure	No. of Cases	Wound Failure	Flat Chamber after 72 Hours	Iris Prolapse	Incarcerated Iris Root
2 McLean type corneoscleral sutures	67	7	4*	1	2
Single preplaced sclerocorneal mattress suture	96	11	5†	2	4

* Two of these required air injection.
† None of these required air injection.

TABLE 2

COMPLICATIONS ON SUTURE REMOVAL

Method of Closure	No. of Cases	Loss of Anterior Chamber	Hyphema	Secondary Closure
2 McLean type corneoscleral sutures	67	3	3	1†
Single preplaced sclerocorneal mattress suture	96	1	2*	1*

* One case had wound disruption as well as hyphema.
† Fistula at suture site.

the silk suture where it perforates the conjunctival flap. This drainage was readily demonstrated with fluorescein.

Table 2 shows the complications upon the removal of sutures. It is evident here that complications on suture removal are somewhat greater in the group where the McLean type sutures were employed. In only two cases with the mattress suture did some complications arise on suture removal. In six of the 67 with two corneoscleral, McLean type sutures, complications developed on suture removal. Of the three complications listed for the mattress suture group two occurred in one patient, namely, wound disruption, loss of chamber, and hyphema. This necessitated secondary wound repair. Of the six complications occurring in the group with corneoscleral sutures, only one required surgical intervention. This was in a patient with secondary loss of chamber on suture removal. A persistent fistula at the suture site required secondary closure.

In both groups the amount of postoperative astigmatism was not great (table 3). There was a suggestion of slight superiority of the two corneoscleral sutures over the preplaced mattress suture. In the mattress suture group 8.0 percent had three diopters or more astigmatism while only 5.2 percent of the corneoscleral suture group had three diopters or more. There was no difference in the final visual results in the two groups and these data are not presented.

There was no other significant difference between the two groups when compared for a variety of postoperative complications (table 4).

Discussion of technique

Ease of the removal of this suture was one of its greatest advantages. The only exposed portion of the suture lay parallel to the wound and two mm. below it. There was a long corneal exposed portion which was readily cut.

The wound was held accurately by two preplaced strands traversing the wound about four-mm. apart. There was no other tissue included in the sclerocorneal closure and therefore apposition was secure. The number of suture loops to manipulate at

TABLE 3

POSTOPERATIVE ASTIGMATISM

Technique	No. of Cases	Under One Diopter (percent*)	1.00 to 1.75D. (percent)	2.00 to 2.75D. (percent)	3.00 to 3.75D. (percent)	4.00 to 4.75D. (percent)	Over 4.75D.
Corneoscleral sutures McLean type	55	38.2 21*	36.4 20	20.0 11	3.6 2	1.8 1	0.0
Preplaced mattress suture	65	30.5 20	33.8 22	27.7 18	4.6 3	3.4 2	0.0

* The number of cases is recorded underneath percentage figure.

TABLE 4

COMPLICATIONS FOLLOWING CATARACT EXTRACTION

Technique	No. of Cases*	Incomplete Wound Closure (percent)	Hyphema (percent)	Irido-cyclitis (percent)	Prolapse of Iris (percent)	Secondary Glaucoma (percent)	Detached Retina (percent)
Two corneoscleral sutures McLean type	67	0.0	4.5 3	3.0 2	1.5 1	1.5 1	1.5 1
Preplaced sclerocorneal mattress sutures	96	1.0 1	3.2 3	2.0 2	2.0 2	2.0 2	0.0

* The number of cases is recorded underneath percentage figure.

operation was reduced to two by not including conjunctiva in the suture.

Since the suture did not pass through the flap at the site of the wound, there was little tendency for postoperative filtration to occur about the suture. Also there was little danger of tearing the flap at its base by passing the suture through the root of the flap.

In corneoscleral sutures that include the conjunctiva, the exposed portion runs across the wound. Removal is fraught with such hazards as cutting the flap, wound perforation or separation, the development of fistula, loss of chamber, and hyphema. The frequency of these complications has led some ophthalmologists to allow the corneoscleral sutures to slough out of their own accord. While this may increase the safety of that method, the increase in morbidity and discomfort to the patient makes such a practice undesirable.

The disadvantage of this technique is the dependence on one suture for holding sclera and cornea together. However, if the suture is put in properly the wound is held securely.

SUMMARY

A technique for preplacing a sclerocorneal mattress suture was described using a corneal hinged flap and a corneal groove. The suture ties on the cornea and does not pass through the flap.

A comparison of this method of closure with preplaced corneoscleral sutures indicated that there were less complications at the time of suture removal with the use of the preplaced mattress suture and that while wound failure in the two groups occurred with equal frequency, secondary operative correction was not required as often when the mattress suture was employed. In addition, the mattress suture was simpler to insert and to remove than two corneoscleral sutures. There was no other significant difference between the two groups when compared for a variety of postoperative complications.

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THE EFFECTS OF IRRADIATION UPON VISUAL PURPLE*

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INTRODUCTION

The most characteristic property of the photosensitive visual pigments is their absorption of light and the subsequent splitting of the molecule into at least two portions. One of these is a specific protein. The second is retinene, vitamin-A aldehyde.[1] The combination, between retinene and protein, resulting in the formation of photosensitive pigment, is most likely a union between the aldehydic group of the retinene and a primary amino group of the protein.[2]

It has also been shown that sulfydryl groups appear during the bleaching of visual purple.[3, 4] From a consideration of the reactivity of the sulfhydryl and aldehyde groups a second type of bond formation is possible, that between the SH and aldehyde portions of the two components.

The work of Barron[5] and others has demonstrated that SH-containing enzyme systems are particularly susceptible to inactivation by irradiation, the primary effect being attributed to the production of peroxides in the aqueous medium and the resulting oxidation of the SH groups. If this type of structure is concerned in the formation of the visual purple molecule, irradiation should destroy a significant portion of the visual purple provided the SH bond is accessible to the oxidants formed upon irradiation of the aqueous solution. If, however, an aldehyde SH bond is stable in the visual purple molecule, then the oxidants would have little effect upon it.

METHODS

Several types of Rana pipiens preparations were used in this investigation. These consisted of intact animals, open optic cups, suspensions of the distal segments of retinal rods prepared by the method of Saito[6] and solutions of visual purple in digitonin, extracted from rod distal segments.

Irradiation was carried out in a variety of ways as will be indicated under discussion of results.

All spectrophotometric measurements were made with the Beckman DU spectrophotometer.

RESULTS AND DISCUSSION

a. INTACT ANIMALS

1. Six dark-adapted intact animals were exposed in the dark to 3,000 r (X rays) in a period of 30 minutes. Six controls were treated similarly except for the absence of irradiation. After exposure both sets of animals were killed and the visual purple extracted in two-percent digitonin buffered at pH 7.0.

Figure 1 shows a typical absorption spectrum for this type of treatment in which the difference in density between bleached

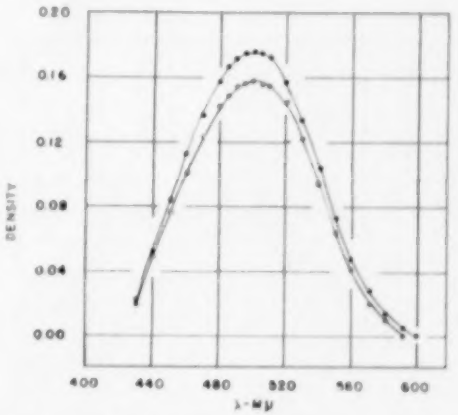

Fig. 1 (Peskin). Difference spectrum of visual purple in intact frogs. Closed circles, animals irradiated in dark with 3,000 r; open circles, control animals.

* From the Biology Department, University of Rochester. Supported in part by a grant from the U. S. Public Health Service, National Institute of Neurological Diseases and Blindness. Portions of this work were carried out at the Biology Department, Brookhaven National Laboratory.

and unbleached extracts is plotted against wavelength. It should be noted that the extract from the irradiated animals has slightly higher density than the controls.

This difference is fortuitous since the retinas of the animals used in each set cannot be expected to be identical in size. The significant factor is that irradiation with 3,000 r (X rays) does not destroy the visual pigment in an intact frog.

2. Six frogs were light adapted by remaining for one hour in bright sunlight. They were then irradiated with 3,000 r (X rays) in the light and again exposed to sunlight for one hour. Following this they were kept in the dark for 24 hours after which the visual pigments were extracted in digitonin solution. The control animals were treated in an identical fashion except for the irradiation.

Figure 2 shows the results of this treatment. The irradiation does not destroy the ability of the retina to regenerate visual pigment. During the period of dark adaptation following the exposure to sunlight both the irradiated and control animals regenerated equal concentrations of pigment. Again the slight differences in concentration, in this case slightly higher in the treated animals, is attributable to slight differences in the size of the retinas.

b. Retina preparations

Twelve retinas were removed from the frogs after complete dark adaptation. These were irradiated with 3,000 r (X rays) and extracted in two-percent digitonin. An additional group of 12 retinas was prepared in an identical fashion except that they were not irradiated.

Figure 3 is a typical absorption spectrum for this experiment. Again it is seen that the irradiation does not destroy the visual pigment.

c. Rod segment preparations

The distal rod segments from 50 retinas were removed according to the method of Saito[6] and were divided into three equal portions. One served as control and two samples were irradiated, one at 10,000 r (X rays), the second at 300,000 r (X rays). After irradiation, the suspension of rods was centrifuged and the packed rod segments extracted in two-percent digitonin.

In this case it is seen from Figure 4 that the solutions irradiated at 300,000 r showed a slight decrease in visual purple concentra-

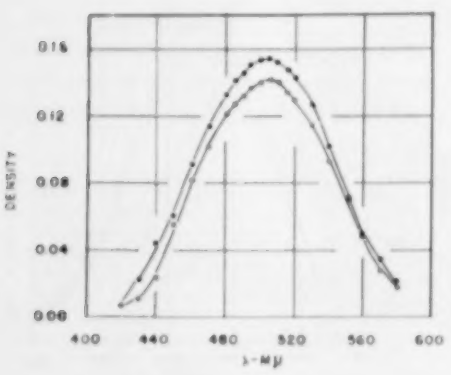

Fig. 2 (Peskin). Difference spectrum of visual purple in intact frogs. Closed circles, animals light adapted, irradiated with 3,000 r in the light and dark adapted before assay. Open circles, control animals.

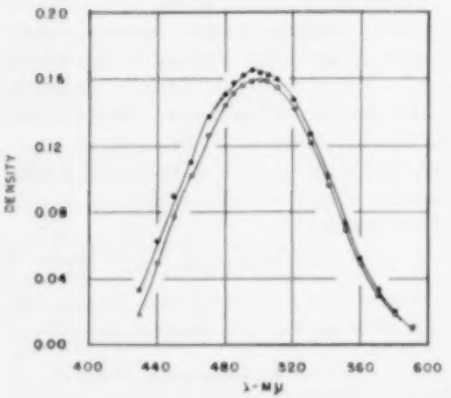

Fig. 3 (Peskin). Difference spectrum of visual purple in frog retinas. Closed circles, retinas irradiated in the dark with 3,000 r; open circles, controls.

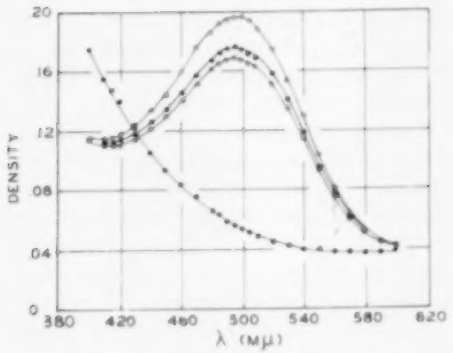

Fig. 4 (Peskin). Absorption spectrum of visual purple in distal segments of retinal rods. Open circles of uppermost curve, controls; closed circle of next lower curve, rod segments irradiated with 10,000 r; open circles of next lower curve, rod segments irradiated with 300,000 r; bottom curve, closed circles, absorption spectrum of light bleached control visual purple solution.

tion but the major portion of the pigment was not destroyed. A similar series in which the exposure was 3,000 r (X rays) showed no effect on the visual pigment. Here again it is seen that even large doses of X rays have only a slight effect on the visual purple molecule.

d. Visual purple solutions

Solutions of visual purple were prepared in two-percent digitonin from rod segments separated as in the previous section and buffered at pH 7.0. Each solution was divided into three portions and irradiated at 3,000 r and 300,000 r (X rays).

A typical result is shown in Figure 5. Here again it is seen that the irradiation causes only slight decreases in the visual pigment concentration, the bulk of the pigment remains unaffected after exposure.

e. Dried visual purple

Solutions of visual purple prepared as in Section d were dried on glass cover slips. These were then mounted in a vacuum chamber and irradiated with electrons from the van de Graff generator to a total exposure of 5×10^6 r. The transmission of the dried film was measured before and after exposure to the radiation.

The result of such an experiment is shown in Figure 6. In this case it is evident that the absorption spectrum is considerably altered.

The most significant change is the large increase in absorption at the blue end of the spectrum. This is characteristic of the changes which accompany the bleaching of a visual purple solution.

It is evident from the shape of the absorption curves that the visual purple has been largely destroyed. The absolute position of the two curves is not significant. The factor to be considered is the shape of the curve.

In a second type of preparation visual purple solutions were dried at high vacuum, ground into powder and irradiated as above.

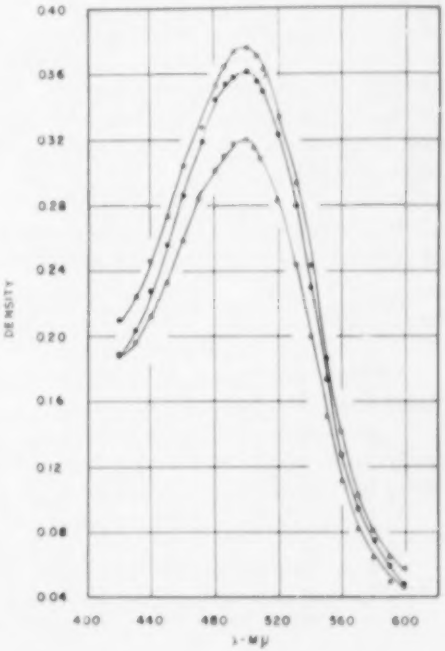

Fig. 5 (Peskin). Difference spectrum of visual purple when irradiated as solution. Open circles of uppermost curve, control; closed circles of middle curve, irradiated with 3,000 r; open circles of bottom curve, irradiated with 300,000 r.

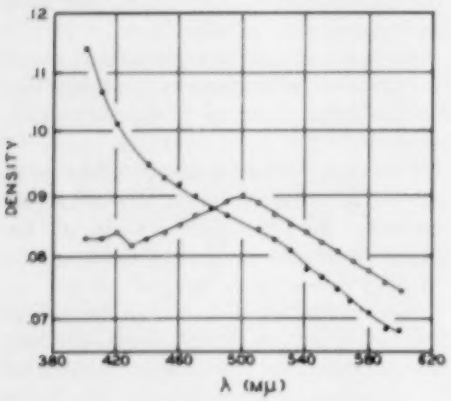

Fig. 6 (Peskin). Absorption spectrum of visual purple when irradiated by electrons to a total exposure of 5×10^5r. Open circles, control; closed circles, irradiated film.

The powder was redissolved in water and the absorption spectrum measured before and after bleaching. This is shown in Figure 7. It is evident in this case that a significant quantity of unchanged photopigment remains in these preparations since considerable bleaching occurs when the solution is exposed to light.

Comparison of the absorption spectrum of the preparation irradiated and measured as a dry film (fig. 6) and the absorption spectrum of the dry powder which has been redissolved after equal irradiation (fig. 7) shows that the visual purple molecule is reversibly altered by irradiation.

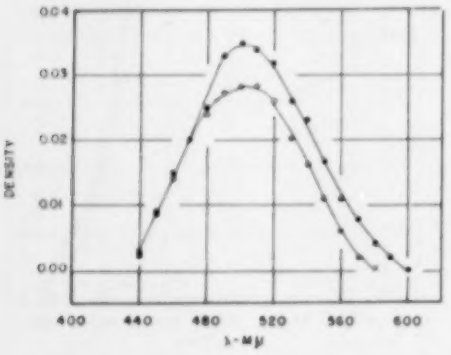

Fig. 7 (Peskin). Difference spectrum of visual purple irradiated by electrons to total exposure of 5×10^5r as a dry powder and redissolved before measurement. Closed circles, control; open circles, irradiated.

Upon being returned to aqueous solution the molecule spontaneously regenerates, indicating that the equilibrium between the bleached products of irradiation and the intact molecule is far on the side of the intact molecule, and that the regeneration of visual purple is an exergonic process. This is a corroboration of the work of Wald who showed the same relationship in studies of the regeneration of light-bleached visual purple.

In the bleaching of visual purple by light at low temperature and in dry gelatine films Wald[8] showed that the first steps in the bleaching of visual purple, as judged by small changes in absorption spectra, is the formation of a series of slightly altered products, meta and lumi rhodopsin. After warming, these early steps are followed both by the spontaneous splitting of the altered molecule into retinene and opsin and the regeneration of visual purple.

When the molecule is bleached by electrons it is bleached beyond the first stages of meta and lumi rhodopsin; but it regenerates to a considerable extent when again placed in aqueous solution rather than dividing equally between bleached products and intact pigment as seen in the work of Wald.

If, as Hubbard and Wald[9] suggest, visual purple regenerates from only one of the several isomers of retinene which are present in solution, and the effect of light is to split the retinene-protein bond with the conversion of the retinene to a nonreacting isomer, then the effect of electron irradiation is to disrupt the same bond as indicated by the appearance of a typical bleached spectrum without causing the isomerization which prevents immediate recombination of the retinene and opsin.

f. Effect of hydrogen peroxide

Since it has been suggested that peroxides which are formed in the aqueous medium

TABLE I

IRRADIATION OF VISUAL PURPLE

λ	Optical Density					
	% H_2O_2					
	0.00	0.10	0.50	1.00	2.00	5.00
450	0.084	0.065	0.057	0.048	0.052	Bleached and Precipitated
500	0.163	0.165	0.161	0.120	0.111	
550	0.087	0.091	0.087	0.039	0.038	

by irradiation are responsible for the alteration of biologic systems, the effect of hydrogen peroxide upon visual purple solutions was examined.

Digitonin solutions of visual purple were diluted with hydrogen peroxide in such a way that the concentration of visual purple remained constant in all samples while the concentration of hydrogen peroxide varied. The changes in such a series are shown in Table 1. Here it is evident that concentrations of hydrogen peroxide below 0.5 percent do not appreciably alter the molecule while concentrations of one percent and higher disrupt the molecule considerably.

If the SH groups are involved in the retinene protein bond in the type of reaction shown by Ratner and Clarke[8] for the cysteine formaldehyde reaction, the bond would not be accessible to oxidation by peroxides as long as the visual purple molecule was intact. The changes produced at high peroxide concentrations are more extensive than the direct bleaching of the molecule since the solutions become appreciably turbid upon standing, indicating that the proteins are beginning to precipitate.

Since low concentrations of peroxide do not destroy visual purple, the quantities produced in the irradiated aqueous media are obviously too small to cause bleaching and the effect of irradiation, where apparent, is by direct disruption of a sensitive portion of the molecule. The disruption of the photosensitive molecule by irradiation is not followed by isomerization of the retinene or denaturation of the protein and the two products can recombine to produce visual purple in almost the same quantity as was present in the original solution.

SUMMARY

Irradiation of visual purple with X ray causes little or no destruction of the molecule. This is apparent in intact eyes, isolated retinas, isolated retinal rods, and in solution of visual purple.

Irradiation of dry preparations with electrons causes extensive changes in the molecule which persist in the dry condition but disappear upon the introduction of water.

The effect of radiation is different from light in that pigment alteration occurs only in the dried condition, and it is likely that the irradiated molecule returns to its original state upon wetting, in contrast to the permanent changes which occur in light irradiated dried visual purple.

The negligible effect of low peroxide concentration indicates that the SH groups of the protein are not accessible to oxidation by peroxides produced during irradiation of an aqueous solution.

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NATURE OF INNERVATIONAL HYPERPHORIA*

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In a classic article White[1] maintained that the predominant cause of hyperphoria was a weakness of one or more of the elevators or depressors and demonstrated simple methods of identifying the offending muscle. These findings were confirmed and elaborated by Scobee[2] but Scobee doubted that the muscle weakness found in hyperphoria was a paresis as assumed by White and preferred the noncommittal designation of involved muscle.[3] He noted that the inferior oblique, though rarely the cause of paretic hypertropia, is frequently involved in hyperphoria and hence concluded that hyperphoria is commonly of innervational origin. In this regard the effect on heterophoria of shifting the fixation of the eyes is instructive and of some clinical importance.

SHIFT IN FIXATION

Dolman,[4] in a study of 100 cases, observed that 66 revealed more heterophoria when the Maddox rod was placed before the nondominant eye, 17 had more heterophoria with the rod before the dominant eye, and 17 gave identical measurements regardless of which eye was behind the Maddox rod.

In the past war the ocular muscle balance of prospective aviators was tested somewhat differently by the Army and the Navy. The naval examiners placed the Risley prism before one eye and the Maddox rod before the opposite eye while the Army used the Risley prism and Maddox rod before the same eye. In the absence of a test prism one fixes usually, though not invariably, with the eye looking through the red glass rather than that behind the Maddox rod. The obscuration produced by the addition of a prism, and especially a Risley prism, tends to definitely shift the fixation to the opposite eye. As a consequence, with the Navy technique the candidate fixed with the eye behind the Maddox rod while with the Army method fixation was maintained by the eye having the red glass. When a group was tested by both methods, Green and Scobee[5] found that the two procedures did not give equivalent findings. The variation in lateral phoria was such that a measurement by one method could be converted into that of the other, but in the tests for vertical phoria, at both distance and near, no satisfactory interchangeability was possible.

Some patients whose eyes give an equal corrected acuity nevertheless report that one eye has a brighter image. This eye may or may not be dominant. From my experience it seems that that eye has the brighter image which when fixing gives the least lateral phoria for distance or near. This eye presumably receives a steadier and hence brighter image. In testing such patients with the screen and parallax test, the movement often appears faster in one direction than in the other.

Adequate examination of a vertical phoria

* From the Department of Ophthalmology, Northwestern University Medical School. Read before the Chicago Ophthalmological Society, November 15, 1954.

must include at least four tests—two distant tests with the Maddox rod before the right and left eyes respectively, and two similar tests with the fixation light in the reading position. In each case the measuring prisms should be placed over the Maddox rod to assure continued fixation of the eye behind the red glass. In each test the change in vertical phoria upon shifting the head or eyes about 20 degrees to either side should be noted likewise. The danger of relying on one measurement of hyperphoria is illustrated in the following:

CASE 1

A woman, aged 25 years, had diplopia since childhood. Her refractive error was: R.E., −2.0D. sph. ⌒ −0.75D. cyl. ax. 15° = 20/13; L.E., −2.25D. sph. ⌒ −0.75D. cyl. ax. 155° = 20/13. The left eye had the brighter image. The lateral phoria, tested with correction, was for distance 18$^{\Delta}$ exophoria with R.E. fixing, 15$^{\Delta}$ exophoria with L.E. fixing; for near, 40$^{\Delta}$ exophoria with R.E. fixing, 35$^{\Delta}$ exophoria with L.E. fixing. Tested without glasses she had for distance 2.0$^{\Delta}$ right hyperphoria with R.E. fixing, none with the L.E. fixing, and none for near with either eye fixing.

Her previous oculist had prescribed the correct lenses, but later in the hope of lessening her discomfort added 2.0$^{\Delta}$ base-down to the right lens, a combination that only added to her discomfort.

The variation in hyperphoria on shifting the Maddox rod from one eye to the other has been attributed by Posner[6] to a superimposed alternating hyperphoria. He argues that if a patient has 6.0$^{\Delta}$ right hyperphoria with the Maddox rod over the right eye and 2.0$^{\Delta}$ right hyperphoria with the Maddox rod over the left eye, he has 4.0$^{\Delta}$ of essential right hyperphoria and 2.0$^{\Delta}$ of alternating hyperphoria. Had Posner tested vertical phoria in the reading position also, its paretic nature would have been evident and he would have correctly ascribed the variation noted to the primary and secondary deviations characteristic of paresis. In my experience low degrees of alternating hyperphoria are not influenced by the direction of gaze. Posner's special interest in eye movements showing primitive postural patterns[7]—such as divergence and Bell's phenomenon—explains his exaggerated emphasis on such mechanisms, which obviously cannot explain likewise the diverse types of anisophoria associated with anisometropia.

INNERVATIONAL FACTOR

Ocular muscle imbalance may be anatomic, paretic, or innervational in origin. Scobee[8] concluded that heterophoria appearing in the first six years of life was most often due to some anatomic abnormality involving origin or insertion, check ligaments, or adventitious muscle slips. Innervational heterophoria, on the other hand, is associated with adults and its prevalence tends to increase with age.

Adler[9] holds that a hyperphoria of either eye of 1.0$^{\Delta}$ nearly always gives rise to symptoms and hence considers only 0.5$^{\Delta}$ of hyperphoria within the physiologic range. Scobee[10] found that less than two percent of the normal population had more than 1.0$^{\Delta}$ of hyperphoria at near or far as measured by the Maddox rod. An increased incidence of hyperphoria is associated with asthenopia, anisometropia, aniseikonia, excessive exophoria or esophoria, and suppression amblyopia of minor degree. Among Scobee's asthenopic patients, 35 percent had a hyperphoria of 0.5$^{\Delta}$ or more. In anisometropia with a difference of 0.75D. or more in the vertical meridian, I found that 80 percent of cases had significant hyperphoria—1.0$^{\Delta}$ or less in 31 percent, and over 1.0$^{\Delta}$ in 49 percent.

In the present analysis of 100 additional cases of hyperphoria (table 1), the vertical phoria was tested for distance and near with each eye fixing in turn. For the most part the patients tested were those with anisometropia. The change of fixation occasioned unequal measurements in 55 with a disparity

TABLE 1

ANALYSIS OF 100 CONSECUTIVE CASES OF HYPERPHORIA

Prism Diopters	Highest Hyperphoria (Cases)	Fixation Shift (▲) in Hyperphoria (Cases)	Hyperphoria without Fixation Shift (Cases)	Distance:Near	
				Greatest (▲) Difference (Cases)	Least (▲) Difference Cases)
0					38
0.5		25	15	14	30
1.0	27	14	14	32	16
1.5	12	5	4	12	6
2.0- 2.5	24	8	4	24	8
3.0- 3.5	8	3	6	10	2
4.0- 4.5	8			2	
5.0- 5.5	8		1	2	
6.0- 6.5	5		1		
7.0-13.0	8			4	

of 1.5$^{\Delta}$ or less in 80 percent of this group. The highest hyperphoria was 2.5$^{\Delta}$ or less in 63, and the greatest divergence between the distant and near findings was 1.5$^{\Delta}$ or less in 58. In all cases the deviation simulated a paresis in some respects but the low degree of impairment generally found rather suggests some innervational correlation. This idea is supported by the frequent concomitance of anisometropia and the tendency of the hyperphoria to develop generally after adolescence and to increase with the degree of anisometropia. In extreme cases of anisometropia, the vertical phoria may be quite marked as the following example illustrates:

CASE 2

A woman, aged 54 years. Refraction: R.E., −9.0D. sph. ⌒ −1.25D. cyl. ax. 180° = 20/40; L.E., +1.0D. sph. ⌒ −2.25D. cyl. ax. 100 = 20/13. Presbyopic addition, 1.75D. Tested without correction, the vertical phoria was for distance 13$^{\Delta}$ right hypophoria with R.E. fixing, 10$^{\Delta}$ right hypophoria with L.E. fixing; and for near 1.0$^{\Delta}$ right hypophoria with R.E. fixing and no hypophoria with L.E. fixing. Prismatic imbalance in near vision could be readily eliminated by the aid of these data. The lenses induced at the reading level 8.0$^{\Delta}$ base-down, R.E., which was offset completely by 5.0$^{\Delta}$ base-up in the right lens, 1.5$^{\Delta}$ base-down, in the left lens and dissimilar segments (R. Fulvue, L. Kryptok). Though her optician had frankly communicated his doubts about this complicated prescription, she found the glasses to her surprise immediately satisfactory.

The refractive changes incident to age cause occasionally a significant diminution of a previous anisometropia, but the original hyperphoria tends to persist, as in the following instance:

CASE 3

A paint dealer at the age of 55 years required for distance vision: R.E., +0.25D. sph. ⌒ +0.25D. cyl. ax. 65° = 20/15; L.E., −1.0D. cyl. ax. 20° = 20/15—giving 1.2D. power variance in the vertical meridian. At the age of 71 years his correction had changed to: R.E., +1.25D. sph. ⌒ +0.25D. cyl. ax. 20° = 20/15; L.E., +1.0D. sph. ⌒ +0.25D. cyl. ax. 110° = 20/15—reducing the vertical power difference to 0.4D. With either eye fixing he still showed 2.5$^{\Delta}$ left hypophoria for distance and none for near.

Scobee[2] found that the constant wearing of vertical prisms was linked with an increase in hyperphoria in 18 percent of patients. He attributed the tendency to impeditive anatomic anomalies, but another interpretation seems plausible. Anisometropia due to the refractive elements of the eye results in aniseikonia and consequent anisophoria.

When one eye has a magnification of two percent relative to the other, the eye with the higher magnification must turn more than its fellow to fixate a point 20 degrees down—in Case 3 two percent of 20 degrees, that is, 0.4 degrees or 0.7$^{\Delta}$. A prism does not alter the aniseikonia, and hence an innervational impulse to anisophoria persists. The increase in hyperphoria that occasionally follows the constant wearing of a prismatic correction is exemplified in:

CASE 4

A man, office worker, habitually returned for examination about every three years with the same complaint—that he "did not focus fast or sharp enough." When first seen, at the age of 28 years, his refraction was: R.E., −2.25D. sph. ⌒ −1.75D. cyl. ax. 170° = 20/15; L.E., −0.75D. sph. ⌒ +2.0D. cyl. ax. 97.5° = 20/25. He then had lateral orthophoria for distance, 6.5$^{\Delta}$ exophoria for near; and with either eye fixing had 1.5$^{\Delta}$ left hyperphoria for distance, and 1.0$^{\Delta}$ left hyperphoria for near. Consequently, 1.0$^{\Delta}$ base-down was added to the left lens. The vertical muscle imbalance steadily increased and at each examination the indicated prism was ordered. At the last visit, the patient, then aged 42 years, tested: R.E., −2.75D. sph. ⌒ −0.75D. cyl. ax. 90° = 20/15; L.E., −0.25D. sph. ⌒ −0.75D. cyl. ax. 20° = 20/25. With either eye fixing he had 6.0$^{\Delta}$ left hyperphoria for distance and 3.0$^{\Delta}$ left hyperphoria for near. A total of 5.0$^{\Delta}$ was prescribed—2.0$^{\Delta}$ base-up, R.E., 3.0$^{\Delta}$ base-down, L.E. This compensated the 2.0$^{\Delta}$ base-down, R.E., induced by the anisometropia at the near point and fully corrected the intrinsic vertical imbalance at the reading level.

INHIBITION

An oculorotary muscle has such excessive reserve power that the source of ordinary hyperphoria is much more likely to be innervational than muscular. Extraocular muscles never need contract more than one fourth their length, while skeletal muscles may contract to almost one half. No ocular movement demands more than 5.0 gm. force, though the potential power of the muscles is over 750 gm. Two possibilities could explain the paretic attributes generally present in hyperphoria—namely true paresis or tonic motor inhibition. Under certain known conditions of altered physiology the visual apparatus exhibits prolonged sensory or motor inhibition. In the sensory field inhibition induces various degrees of suppression amblyopia. An example in the motor field is the normal tonic cortical inhibition of convergence which, when removed by alcoholism or anoxia, results in increasing esophoria. I would suggest that under the influence of some aberration, such as anisometropia or aniseikonia, a tonic inhibition of an extraocular muscle is conditioned. Such a tonic inhibition would impair muscle function according to the extent of the aberration and thus cause a simulated paresis of the involved muscle. In contrast to paretic hyperphoria, I would consider that inhibitive hyperphoria has these characteristics: elevation or depression is generally within moderate bounds, the disparity between primary and secondary deviation is moderate or nil, the variation with conjugate movement of the eyes to either side is small, and effective symptomatic control can be achieved by a properly selected prism.

CLINICAL SUGGESTIONS

1. A vertical prism should be prescribed only after the vertical phoria has been tested with each eye fixing in turn for distance and near and after taking into account any prismatic imbalance induced by an anisometropic correction.[11]

2. The vertical muscle balance at the near point is more important than that for distance as the customary gaze is below eye level. A hyperphoria for distance only does not necessarily require correction. Small amounts of hyperphoria in the reading field

demand attention as they are less likely to be associated with suppression than large amounts and consequently cause more visual discomfort. If the vertical phoria is greater for distance than for near, only that for near generally requires adjustment.

3. If the vertical phoria is greater for near than for distance and the patient is wearing single vision lenses, about 1.0$^{\Delta}$ can be corrected by the size differences possible in readily available lenses.[11] Larger prismatic corrections, 1.5$^{\Delta}$ to 5.0$^{\Delta}$, require a slab-off. In bifocal wearers prismatic correction in the reading field can be obtained by dissimilar segments, slab-off, or both combined.

4. In anisometropic myopia with poor fusion but with good correctible acuity in each eye, the ocular muscle balance can be neglected by fitting the less myopic eye for distance and the more myopic eye for near, reducing the spherical correction for the latter by 2.25D. to 2.50D.*

5. If the patient habitually fixes with the involved eye, the greater amount of prism should be placed over the other eye to correct secondary deviation.

6. A vertical phoria that changes markedly on moving the eyes to the right and left is not amenable to prismatic correction.

7. Adults with anisometropia should be tested routinely for anisophoria as the two conditions are then commonly associated.

Summary

Innervational hyperphoria, though of somewhat vague connotation, generally implies an acquired functional response to some pre-existing aberration. Of the various aberrations implicated the most frequent are probably anisometropia and aniseikonia. The paretic attributes of the anisophoria may be explainable by a tonic motor inhibition of the involved muscle. In innervational hyperphoria the primary and secondary impairments are usually much less than in true paresis, the disparity between primary and secondary deviation is moderate or nil, the variation with lateral conjugate movement of the eyes is small, and effective symptomatic control can be achieved by a properly selected prism. Proper evaluation demands testing the vertical phoria in distance gaze and at the reading level with each eye fixing in turn. In each case the measuring prism must be placed over the Maddox rod to assure continued fixation of the eye behind the red glass.

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* This arrangement is particularly indicated in presbyopia and in the presence of marked phorias as in this case: An optometrist, aged 51 years, required the following correction: R.E., −6.0D. sph. ⊂ −0.75D. cyl. ax. 70° = 20/13−; L.E., −4.5D. sph. ⊂ −0.5D. cyl. ax. 75° = 20/13. Left eye dominant. Tested with corrections for distance and near extreme exophoria disclosed, −14$^{\Delta}$ for distance, 28$^{\Delta}$ for near. The vertical imbalance, tested without corrections, showed a right hyperphoria—with the left eye fixing, 2.5$^{\Delta}$ for distance and near; with the right eye fixing, 3.5$^{\Delta}$ for distance, 1$^{\Delta}$ for near. The right eye was fitted for near by reducing the sphere 2.25D. while the left correction for distance acuity was unchanged. By suppressing binocular vision his muscular difficulties were eliminated.

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WOUND HEALING AND WOUND STRENGTH OF SUTURED LIMBAL WOUNDS*

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INTRODUCTION

While tensile strength has been evaluated in the field of general surgery,[1-8] to date it has not been evaluated for ophthalmic wounds. These methods for measurement of tensile strength allow objective determination and comparison of incision and suture techniques. The method to be described utilizes a tensiometer to determine the regain of strength following keratome incisions through the limbus of cats.

Dunnington[9] and Dunnington and Regan[10] have described the histologic pattern of healing limbal wounds. The following study correlates the histologic picture with the tensile strength as determined by the tensiometer.

METHODS

TENSIOMETER

The tensiometer utilized in this study is the type used by Dennis[1] and Fast, et al.[2] Following their advice that a constant rate of pull on the tissue is necessary, a motor was placed in the system. By utilizing reduction gears, the speed of the motor was decreased to four R.P.M. A commercial weighing scale was incorporated for actual measurement of the breaking strength of tissue. This scale was calibrated against mercury weights before, during, and following the completion of the animal studies. There was negligible change in the scale readings throughout the study.

The strip of tissue to be tested is gripped in two forceps which remain perpendicular to the line of tension (fig. 1).

PREPARATION OF ANIMALS

Cats were kept on a stock diet. All cats were observed in the laboratory animal room at least one week before being operated upon. They were unselected with regard to weight, size, or sex. No animal with a pathologic condition of the eyes, adnexa, or region of the orbit was used.

The cats were anesthetized by an intraperitoneal injection of aqueous sodium pentobarbitol, approximately 40 mg./kg. of body weight.

PREPARATION OF INSTRUMENTS AND OPERATIVE FIELD

The hair was removed from the region of the orbit by means of a commercial animal clipper with a fine, short-cutting blade. The skin about the orbits was then washed with alcohol and iodine or 1:1,000 aqueous Zephiran. A sterile field was maintained by the use of sterile towels and drapes. The eyes of the animal were prepared with two or three drops of 10-percent argyrol which was allowed to remain in contact with the anterior surface of the eye for at least five minutes. Just prior to surgery, the eye was washed with sterile saline until the washings were completely free from the brown color imparted by the argyrol.

The operator's hands were prepared by a standard preoperative "scrub" with Physoderm. Surgical instruments were autoclaved

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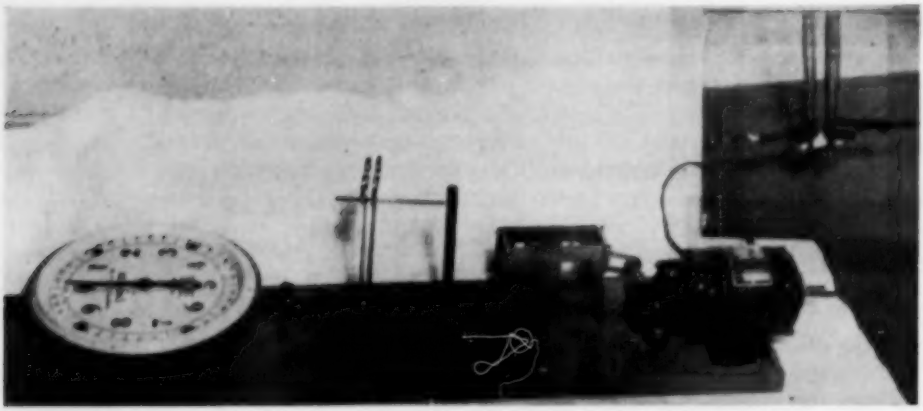

Fig. 1 (Gliedman and Karlson). Tensiometer employed for determination of strength of tissues. The strip of tissue to be tested is gripped in two forceps which remain perpendicular to the line of tension. The tension is slowly increased by the revolving axle which is connected to one of the forceps on the tissue. The amount of tension is registered on the scale. Control strips regularly ruptured at the limbus. The insert shows a close-up of the forceps gripping the tissue.

between procedures on different animals. When both eyes of an animal were done at the same sitting, the surgical instruments were placed in 1:1,000 aqueous Zephiran during the interval between operations, fresh towels and drapes (sterile) were used, and the operator's hands were rescrubbed.

The sharp instruments, keratomes, and scalpel blades, were sterilized in commercial Bard-Parker solution, remaining there at least one hour before use. Suture material, 6-0 atraumatic eye suture of braided silk, was sterilized in Bard-Parker solution and was not autoclaved.

Operative technique

A lateral canthotomy was performed, and the lids were held apart by a self-retaining eye speculum. The nictitating membrane was amputated. The bulbar conjunctiva was incised at the limbus, undermined, and retracted away from the corneoscleral junction. About two or three mm. of conjunctiva were resected to prevent the free conjunctiva from reaching the incision site postoperatively.

A keratome incision was made into the anterior chamber through the limbus at the 12 o'clock position (figs. 2 and 3). The wound was extended with sharp corneal scissors around one-half the circumference of the cornea (fig. 2). The criteria laid down by Dunnington[9] and Dunnington and Regan[10] for the proper method of suturing were employed.

The wound was closed with interrupted 6-0 atraumatic silk eye suture placed to a depth of one-half the incised wound. Sutures were placed at five-mm. intervals with a bite that included about one mm. of each wound lip (fig. 3). Knots were laid flat and tied with one square knot. The tissue was approximated without tension. The canthotomy was closed with 3-0 or 4-0 braided silk suture.

The eye was washed with sterile physiologic saline and the lid speculum was removed.

Evaluation of wound

The cats were examined almost daily. Groups of animals were killed immediately, at 24 hours, 72 hours, six days, nine days, 11 days, 14 days, 21 days, 28 days, 56 days, and six months. A total of 59 eyes were included in this series, and usually four to six deter-

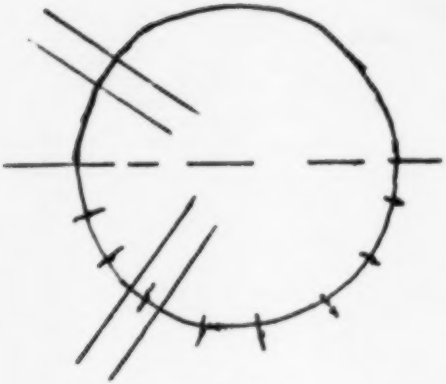

Fig. 2 (Gliedman and Karlson). Sketch showing incised and control limbus. The circle represents the limbus. The horizontal interrupted line separates the healing (upper segment) and control (lower segment) limbus. The parallel lines at the 2-o'clock position outline a typical test strip. The strip was fixed between two clamps, one at the corneal end and one at the scleral end of the strip. At the 4-o'clock position is the outline of a typical control strip.

minations were made on the healing and normal segments of the limbus of each eye. Approximately 500 separate determinations were made.

Animals were killed by a narcotizing dose of sodium pentobarbital followed by intracardiac air (50 cc.). The conjunctiva was resected from the unincised half of the eyeball and the anterior portion of the eyeball was removed, usually about one cm. beyond the limbus. Note was made at this time of the presence or absence of any serous, bloody, or purulent accumulations near the wound, at the suture holes, or in the anterior chamber.

The specimen was placed upon a piece of moist surgical gauze or paper toweling and inspected. Note was made of iris inclusion in the wound or fixation of the iris body to the internal surface of the wound. Following this inspection, the iris, ciliary body, and lens were removed from the specimen. The specimen was cut through the cornea to separate the incised and unincised portions of the limbus (fig. 2). Both the previously intact limbus and the sutured limbus were then sectioned into strips 2.5-mm. wide including both cornea and sclera (fig. 2). Where sutures were present, one was included in each section; however, the sutures regularly sloughed after about three weeks. When this was the case, a section was used that included no suture.

Each 7.5-mm. strip was tested in the tensiometer and the force necessary to separate the approximated wound was measured.

Fig. 3 (Gliedman and Karlson). Position of incision and suture of limbus. The sutures were placed to a depth of one-half the incised wound and included a one-mm. bite of each wound lip.

TABLE 1

THE TENSILE STRENGTH OF SUTURED LIMBAL WOUNDS IN CATS

Healing Period	Number of Cats	Individual Percent of Normal Tensile Strength*	Mean Percent of Normal Tensile Strength†	Standard Deviation of Individual Percent of Normal Tensile Strength‡	Mean Breaking Strength for Day (in gm.)
Immediate	4	5.8, 4.5, 6.8, 7.5	6.1	1.2	100
1 da.	4	4.8, 5.4, 4.4, 4.7	4.8	0.4	87
3 da.	5	7.7, 8.7, 5.8, 6.7, 7.2	7.2	1.0	123
6 da.	5	11.0, 11.0, 9.5, 12.0, 6.3	9.9	2.0	172
9 da.	5	14, 15, 16, 19, 14	15.6	3.2	236
11 da.	9	15, 16, 17, 23, 28, 21, 28, 17, 21	21.0	4.6	290
14 da.	7	44, 40, 32, 30, 29, 31, 32	34.0	5.2	583
21 da.	7	29, 39, 35, 40, 25, 23, 32	32.0	6.1	522
28 da.	7	40, 42, 38, 35, 24, 26, 33	34.0	6.4	611
56 da.	5	47, 45, 37, 42, 32	41.0	5.5	696
6 mo.	1	62.0			1,126

The mean strength for the "control" limbal tissue was 1,612 gm.

* Derived by dividing the mean breaking strength of several wound strips by the mean breaking strength of several control strips of limbus from the same eye.

† The arithmetic mean of the "individual percent of normal tensile strength" values.

‡ Derived from the formula: $s = \sqrt{\frac{SX^2}{n-1}}$

Similar determinations were made on strips of unincised corneoscleral junction to determine the normal tensile strength. The mean tensile strength of the sutured segments from each eye was divided by the mean tensile strength of the previously unincised segments. This figure is the individual percent of normal tensile strength (table 1) for each eye.

One section was taken from each healing limbus for histologic study. This segment was examined for signs of infection as well as studied to correlate the histologic picture with the tensile strength curve.

RESULTS

Of 85 eyes operated upon, 59 are included in the study. Criteria for excluding an eye from the series included:

a. Sutures went the full thickness of the tissue and were in contact with the anterior chamber.

b. Gross or microscopic evidence of infection.

c. Inclusion in the wound of extraneous material, that is, iris.

d. Failure to test more than two strips from the incised or control portions of the limbus.

e. Staphyloma along the wound closure.

The wound strength values, percent of normal wound strength, and statistical data are summarized and tabulated in Table 1 and illustrated graphically in Figure 4.

Immediately following suturing, the limbal wound was 6.5-percent as strong as the previously undisturbed limbus of the same eye. This value decreased for the second 24 hours. After this decrease, there was a gradual rise to the ninth day and then a slightly more accelerated rise in strength occurred to the 14th day. Following the 14th day, the wound strength curve reached a plateau with a gain in strength of about one percent of normal wound strength per week. In one wound followed to six months postoperatively, the wound had not reached the strength of normal limbus.

Histologic sections were studied. There was minimal fibroblastic activity, considerable edema of the wound, and an amorphous fibrinous plug at the incision site until the third day. At the suture tract there were leukocytic infiltration, tissue necrosis, and an

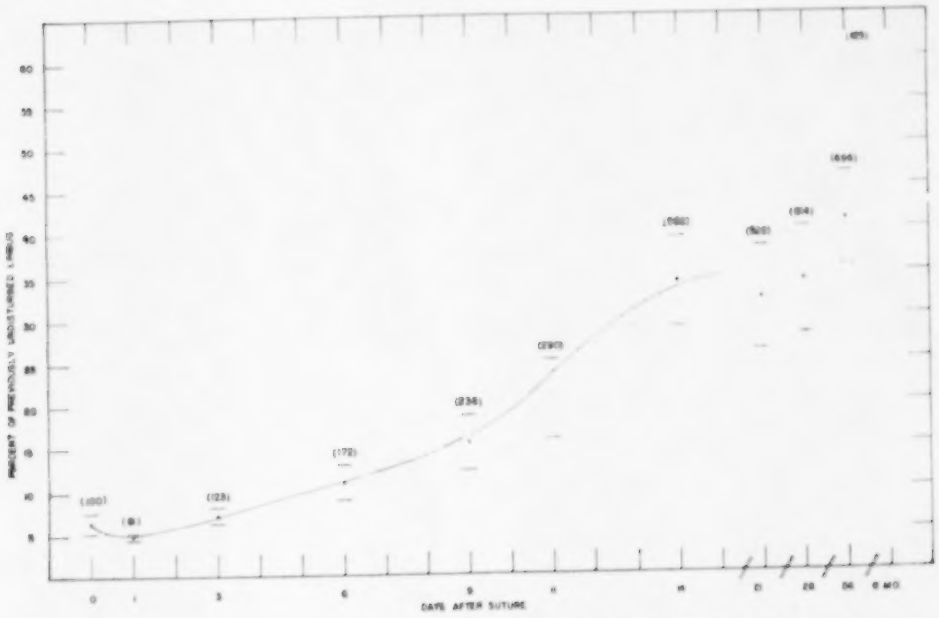

Fig. 4 (Gliedman and Karlson). The tensile strengths of sutured limbal wounds in cats at various periods after repair. The curve passes in all cases within one standard deviation of the mean percent of normal for the day. The boundaries of the standard deviation are outlined by parallel lines; the mean is indicated by a dot. The mean absolute breaking strength (gm.) is indicated in parentheses.

occasional epithelial downgrowth.

From the third day to the sixth day, there was an increasing presence of blood vessels and fibroblasts in the wound; usually during this interval the inner portion of the wound (close to the anterior chamber) showed paucity of proliferating elements (fig. 5).

At nine days, epithelium was usually absent from the suture tracts. There was a gradient of activity, measured by the amount of fibroblastic elements, from the conjunctival surface to the anterior chamber side.

By the 14th day, however, the wound in its entirety was dense with wound-healing elements; some sections showed signs of considerable contracture of the wound and decreased fibroblastic activity, as measured by a decrease in the size of the nucleus of the fibroblast. After the 14th day, there was a continuing decrease in the wound width and the fibroblast nucleus size.

An epithelial layer over the wound usually was absent at the ninth day, a narrow proliferating epithelium was present at about 11 days, and epithelization was completed over the wound at about two weeks postoperatively.

Discussion

The wound-healing curve of limbal tissue can be divided into three phases: a lag phase, a proliferative phase, and a plateau phase. This curve is essentially the same as the healing curve for other tissues; however, the gain of strength is considerably less than the values reported for the regain of strength of skin, fascia, stomach or abdominal wall.[2-6]

Abdominal wall tissue, for example,[2, 7] regained 36 percent from the third day to the 15th day; limbus regained 27 percent for a comparable period. The abdominal wall gained strength fairly constantly from the second day to the 14th day, with an 11-percent gain per two-day interval from days three to nine.

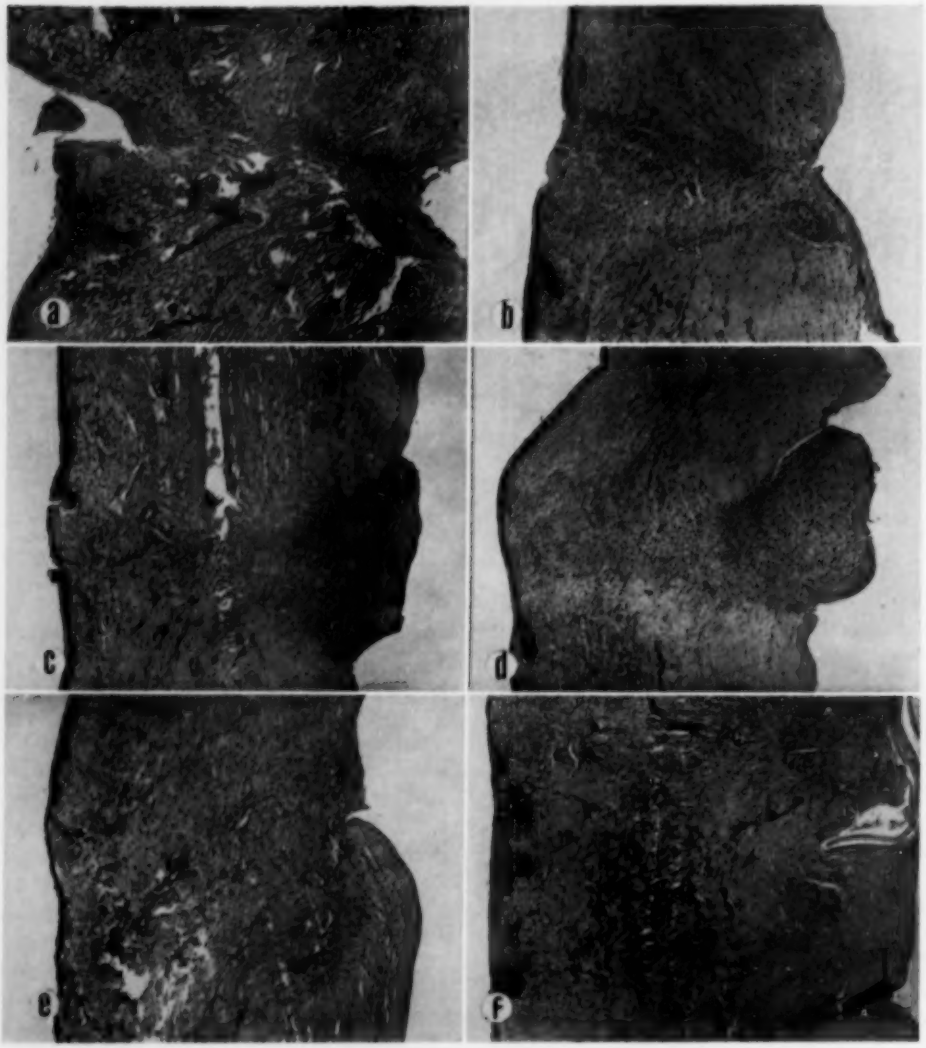

Fig. 5 (Gliedman and Karlson). Photomicrographs of limbal wounds at (a) six days, (b) nine days, (c) 11 days, (d) 14 days, (e) 28 days, and (f) 56 days after suturing, showing ingrowth of fibroblastic elements and the gradual maturation of fibrous tissue throughout the wound, and the progressive spread of epithelium over the surface of the wound.

The limbal wound regained less strength during the first two weeks and showed a continued increase in strength at later intervals. The observed acceleration in regain of strength implies correlation with the more complete fibroblastic proliferation through the entire limbal wound.

A comparison of the tensile strength of the "control" limbal tissue to abdominal wall tissue gives a good index of its relative strength to other body "soft" tissues. In this study, the previously undisturbed limbus, 2.5-mm. wide, disrupted at a mean pull of 1,600 gm., with a relatively small scatter of

values. Fast, et al.,[2] and Grossman[3] obtained values between 1,500 and 4,000 gm. per centimeter of width for abdominal wall strength.

As an explanation of the early weakness of the wound, consideration must be given to two factors: (1) Suture strength and (2) the strength of the tissue through which the suture is placed.

Since the wound lips are held in apposition largely by the suture in the early days of healing, the actual tensile strength of the suture must be considered in evaluating early wound strength. The 6-0 suture used in this study has a USP requirement of 227 gm. for a straight pull and a required knot strength of 113 gm.

It is apparent in reviewing the suture strength and the wound strength during the lag phase that the wound is separating below the breaking point of the suture. Study of the tissue following tensile testing revealed the knotted suture intact in almost all instances. The suture was actually torn out of the tissue when the wound edges separated. What is measured during the lag phase is the strength of one-half the thickness of the limbus modified and weakened by the suture which by fissure affords a plane of cleavage.

Conclusions

1. An objective method for evaluating the strength of eye wounds is presented.

2. Sutured limbal wounds in cats follow, generally, the curve of wound healing of other soft tissues having a lag phase, a proliferative phase, and a plateau phase.

3. In cats the strength of the sutured limbal wound immediately following surgery is 6.5 percent of previously undisturbed limbal tissue from the same eye. After three days, there is a gradual rise in strength until nine days postsuturing. A slight acceleration occurs from the ninth day to the 14th day when a wound strength of 34 percent of the undisturbed limbus is reached. Thereafter, there is a plateau with a gain in strength of about one percent per week.

4. The wound-strength curve was found to parallel the histologic picture. The lag phase in the wound strength curve correlated with the presence of unchanged fibrin meshwork immediately following wound closure. The gradual rise in strength correlated with the increasing number of blood vessels and fibroblasts. The accelerated phase of the "strength" curve occurred with the infiltration by fibroblasts of the innermost portions of the limbal wound, close to the anterior chamber, and the contraction of the wound.

5. Occasionally the epithelial elements grew down the suture tract; however, at nine days epithelium was usually absent from suture tracts. At 11 days the wound surface showed a thin layer of epithelium actively proliferating and at 14 days the wound was usually well epithelialized.

6. Comparison of the breaking strength of the wound and of the suture alone indicates that suture material heavier than 6-0 is unnecessary.

7. In six months of observation on cats, limbal wounds, sutured in a manner prescribed for optimal histologic healing in monkeys, never regained full preoperative strength.

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OPTICAL IRIDECTOMY: RESULTS IN NINE EYES

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It has long been believed that the procedure of optical iridectomy improves vision. This surgical procedure is often recommended routinely for certain corneal and lenticular opacities and ectopically placed lenses, but in the present era of critical reexamination many principles long held true have been disproved. It seems that an analysis of the visual results in eyes subjected to this operation might show its true value.

It was found in this study that optical iridectomies without antecedent surgery of the lens or cornea are not often performed. In the eye clinic of the Medical College of Alabama from the years 1947 to 1953 (37,000 out-patient visits) and in the private practice of Dr. Alston Callahan, only nine eyes (six patients) received these operations. Optical iridectomies performed for nuclear congenital cataracts were not included because the resulting vision depended more upon the degree of success of cataract surgery and the results of linear extractions and discissions varied so widely that definite conclusions could not be drawn from them. It was my impression after studying the records that optical iridectomies are rarely of value with nuclear congenital cataracts.

In only nine eyes in six patients was an optical iridectomy the only ocular surgery. The diagnoses were:

Eyes with corneal opacities	3
Eyes with congenital ectopic lenses	6

CONCLUSION

Optical iridectomies are likely to improve the vision of eyes with ectopically placed lenses and, to a lesser degree, in eyes with corneal opacities. Optical iridectomies do not seem to improve the vision of eyes with nuclear congenital cataracts.

903 South 21st Street.

(See Table 1 on facing page)

TABLE 1

RESULTS IN NINE EYES WITH OPTICAL IRIDECTOMIES

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
	J. J. H. 12-year-old Negro followed 1½ years	F. D. R. 15-year-old white boy followed 7 months	T. G. 13-year-old Negro boy followed 6 years	J. L. B. 44-year-old white man followed 7 years	R. W. R. 48-year-old white man followed 6 years	C. R. 12-year-old white boy followed 3 years
Primary Diagnosis	Central corneal leukoma, O.S. Anophthalmos, O.D.	Adherent leukoma, O.D.	Congenital ectopic lenses, O.U., with Marfan's syndrome	Central leukoma of cornea, O.S. Phthsis bulbi, O.D.	Congenital ectopic lenses, O.U., with the Marfan's syndrome	Congenital ectopic lenses, O.U., with the Marfan's syndrome
Case History	Patient first seen at the age of 11, when mother gave the story of his having had severe measles at the age of 11 mo. with an unknown bilateral ocular complication. This left him severely handicapped and at the age of 3, the right eye was enucleated. There was a dense, large central adherent leukoma, O.S., with a typical pendular nystagmus of the eye. After surgery, a large pupillary opening was obtained, through which the fundus was seen. Though the structures were distorted, they were probably normal. The mother has noted objective evidence of the child's improvement	Patient was first seen at age 14, with history of having been struck in O.D. by a tree limb, about two weeks prior to admission. There was a corneal laceration with an anterior synechia and iris incarceration. Cornea was turbid at site of uveal adherence, and later an adherent leukoma developed. At time of surgery, the synechia was severed and the iridectomy was performed	Patient was first seen at age of six years, with the complaint of having had poor vision all his life. He was noted at the time to have the typical Marfan syndrome with both digital and ocular manifestations. Each lens was placed ectopically superiorly and laterally, leaving an aphakic aperture, inferonasally in each eye. Optical iridectomies were done in the areas of the aphakic portions with good results	The right eye was lost with phthsis bulbi. A corneal ulcer developed in the left eye and became worse with the destruction of the central area. A large leukoma remained in the center of the cornea. The vision was improved considerably by placing the center of the correcting lens in front of the newly formed pupil	This patient with classical Marfan's syndrome had several children with this similar condition. Each lens was placed ectopically superiorly and temporally leaving an aphakic aperture in each eye inferonasally. The fundi were normal. The optical iridectomies were performed in the aphakic areas, and the patient was given an aphakic correction. The patient was able to obtain employment because of the improved vision	Classical Marfan's syndrome with digital signs as well as ocular. Also, there was a history of heredity. This patient is the son of the patient described as Case 5
Preoperative Vision	O.S., sc: Counting fingers at unstated distance cc: Could not refract	O.D., sc: 20/100 cc: Not refracted preoperatively	O.D., sc: 3/50 cc: Not refracted O.S., sc: 3/50 cc: Not refracted	O.S., sc: 20/400 cc: Could not be improved with refraction	O.D., sc: 20/400 cc: 20/70 O.S., sc: 20/400 cc: 20/200	O.D., sc: 20/200 (?) cc: Not refracted O.S., sc: 20/200 (?) cc: Not refracted
Surgery	Optical iridectomy at 6 o'clock, O.S.	Optical iridectomy at 2 o'clock, O.D.	Optical iridectomy at 6 o'clock, O.D. Optical iridectomy at 6 o'clock, O.S.	Optical iridectomy at 5 o'clock, O.S.	Optical iridectomy at 6 o'clock, O.D. Optical iridectomy at 7 o'clock, O.S.	Optical iridectomy at 7 o'clock, O.D. Optical iridectomy at 6 o'clock, O.S.
Postoperative Vision	O.S., sc: 5/400 cc: Could not improve with refraction	O.D., sc: 20/50+2 cc: 20/50+1	O.D., sc: 2/200 cc: 20/40+2 O.S., sc: 2/200 cc: 20/40−3	O.S., sc: 20/300 cc: 20/100+3, slightly better with telescopic lens	O.D., sc: 2/200 cc: 20/40−2 O.S., sc: 2/200 cc: 20/50	O.D., sc: 2/200 cc: 20/50−1 O.S., sc: 2/200 cc: 20/50−1

EPITHELIAL MEMBRANE IN ANTERIOR CHAMBER AFTER CATARACT SURGERY*

Case report and comments on x-ray treatment

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The growth of epithelium into the anterior chamber of the eye may occur after cataract extraction or after a penetrating foreign body or a stab injury through the anterior segment. Most of the cases reported in the literature were diagnosed histologically in eyes enucleated at the terminal stages of uveitis or secondary glaucoma.

Discussion of the onset, approximate incidence, and mechanism of the epithelial invasion has been adequately covered by Theobald and Haas.[1] Their report included 75 eyes removed at varying periods after cataract extraction between 1934 and 1945. It is interesting to note that 14 of these eyes (18.6 percent) were lost as a consequence of epithelial ingrowth into the anterior chamber. In most of them, the cataract incision was within the cornea and all of the cases showed histologic evidence of delayed healing of the wound. Only in four was it possible to obtain a clinical diagnosis coinciding with the histologic findings. Therefore, it is reasonable to assume that the cases described in the literature do not represent the true incidence of this complication.

Berliner,[2] in 1950, reported nine cases, all occurring within six months. These patients were operated on with corneoscleral sutures and without conjunctival flap. He concluded that these may be important factors in the incidence of epithelial downgrowth. Delay in healing apparently played no part in his cases.

According to Theobald and Haas, and most of the authors cited in their paper,[1] the treatment of epithelial ingrowth is never successful in the presence of severe iritis with hypotension, vascularization of the cornea, or secondary glaucoma. The chances for arresting the proliferation appear to be better if the growth is suspected or detected in the early stages. Therefore, the need for careful and repeated surveys of every corneal wound is self-evident, particularly if there is a delay in healing.

Except for one instance, reported by Vail,[3] in which radium was used successfully, the treatment of choice has been roentgen radiation, started as soon as possible and with high doses. This will be discussed later.

A prophylactic measure, advocated by Theobald and Haas, is the limbus-based conjunctival flap to prevent the passage of any instrument through epithelium. However, this measure is deliberately omitted or cannot be carried out in some cases. Furthermore, it would seem questionable whether even a carefully dissected flap would remove all the epithelium from the sclerocorneal attachment along the entire semicircle of the incision.

Case presentation

G. G. was a white man, aged 71 years, in good health. On August 15, 1952, a diagnosis was made of hypermature cataract in the right eye. Vision was reduced to light perception and projection.

Intracapsular cataract extraction was performed on September 14, 1952. Incision was made with keratome and scissors about one mm. inside the cornea. Basal iridectomy was

* Read before the North-Central Illinois Medical Association, November 5, 1953.

done at the 12-o'clock position. The lens was extracted with Bell's erisophake. Corneoscleral sutures of the McLean type were placed at the 11- and 12-o'clock positions. No immediate complications were noted.

Two weeks postoperatively the corneoscleral sutures were removed. Five days later the patient returned to the office complaining about excessive tearing of the operated eye. Upon examination, the anterior chamber appeared shallow and the eye felt soft. With the slitlamp microscope, a thin well-demarcated opaque line was seen extending over the posterior surface of the cornea from about the 10- to 12-o'clock positions, approximately 2.5 mm. below the edge of the wound. Above that line was a translucid area that seemed to continue it upward. By exerting slight pressure on the cornea, the translucid surface could be observed to move.

There were no exudates in the anterior chamber or at the edge of the coloboma. The iris was free but injected. A definite aqueous flare could be detected. With the aid of fluorescein stain, it was possible to see a thin stream of aqueous fluid leaking intermittently from a fistula in the wound, about two mm. from the point where the 11-o'clock suture had been placed.

After a fruitless attempt to cover the fistula with a conjunctival flap, due to friable tissue, applications with saturated trichloracetic acid were started. These were continued every second day for a total of four applications, until the fistula stopped leaking nine days after the cauterizations were initiated. Intraocular pressure at this time was 18 to 20 mm. Hg (Schiøtz). Atropine and cortisone were used topically thereafter, without visible effect on the aqueous flare or ciliary injection.

On November 18, 1952, X-ray therapy was decided upon. The treatment was carried out with the following radiation factors: 100 kv.p.; no added filter; 15 ma, 25 cm. target skin distance, r per minute 120 (in air). The initial three treatments consisted of 250 r each administered at four-day intervals. The next five treatments consisted of 360 r each, administered at daily intervals. The last four treatments of 400 r each were given at four-day intervals. Total dosage: 4,150 r units, measured in air. The portal was limited to the upper quadrant of the cornea, including the line of incision, by a lead shield.

Twelve days after X-ray treatment was started, a moderate edema of the cornea was noticed but there was no increase in the aqueous flare or in the vascularization of the iris. The tension remained normal throughout the entire period of therapy, and thereafter. Six weeks after the last X-ray application, the eye appeared normal and the aqueous flare could no longer be detected. The translucid membrane had receded about one mm. but it was visible below the scar of the corneal wound. Corrected vision at this time was 20/60.

Re-examinations on October 26, 1953, and April 9, 1954, revealed no change from the above picture except that the corrected vision had improved to 20/40.

Comment on X-ray treatment

In their report, Theobald and Haas[1] mentioned three cases of epithelial ingrowth which had received 300, 1,000, and 1,200 r, respectively, without benefit. Berliner[2] cited a personal communication from Dr. A. Kean, who advocated use of small doses, from 50 to 100 r two to three times weekly, until a total of 600 to 900 r was delivered. Also, a more vigorous form of treatment, 250 r two or three times per week for a total of 1,250 to 1,500 r, with the following factors: 120 kv.; 3 mm. aluminum filter; target skin distance, 30 to 40 cm.; field 4 by 4 cm. Arrest of the epithelial invasion was reported in one case out of nine.

Calhoun,[4] in 1949, presented nine cases treated by X rays in which the results were considered inconclusive. Examination of this data shows that the total dosages administered ranged from 625 r to 2,400 r. Notable in this report is one patient, treated three

and one-half weeks after surgery, who received additional treatments at intervals of about two and one-half months, totaling 5,500 r. The membrane was arrested for one and one-half months and then resumed activity, despite the additional treatments. On the other hand, another case treated 19 months after surgery with only 700 r was apparently cured.

Notwithstanding the indefinite results in his series, Calhoun concludes that high voltage X-ray therapy should be used early.

Merriam,[5] in 1952, cited 27 patients with epithelization of the anterior chamber. X-ray treatment proved effective in 10, or 37 percent. The factors used were: 60 kv., 20 mm., 15-cm. target skin distance, 1.2 cm. portal, and 500 r, twice a week for a total of 3,000 to 5,000 r. This is the largest group of patients treated to date, where all the factors were kept constant and the highest dosages were reached.

The above-mentioned data indicate that, at least in the recent past, there has been no agreement on the standard of X-ray therapy for epithelial downgrowth. However, the following circumstances would seem to favor the use of high doses.

1. The lesion is frequently destructive to the eye, even when treated; therefore, any extraneous reaction occurring as a consequence of vigorous therapy is of very minor importance.

2. Most of the eyes under consideration are aphakic so that the lens, its most radiosensitive structure, is eliminated as a potential source of trouble.

3. Rapidly multiplying cells of the epithelial downgrowth seem more sensitive to radiation than cells of normal stratified epithelium.

4. A larger percentage of eyes appears to have been saved, so far, when uniformly high doses were used in a short treatment period. Nevertheless, additional clinical material and properly controlled experimentation may eventually provide a final answer.

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INVESTIGATION OF CORTICOSTEROIDS IN THE AQUEOUS HUMOR OF NORMAL ANIMAL EYES*

II. Further observations

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In the first paper on this subject,[1] the method of Mader and Buck[2] for the determination of corticosteroids was applied, with slight modification, to the analysis of aqueous humor from the rabbit eye. It was noted that while the crystalline corticosteroids developed maximum heat-stable color in 60 minutes at room temperature, the color produced by aqueous humor was intensified 20 to 30 percent by heating at 50°C. for 10 minutes. No explanation was offered at that time for this observation.

It has now been found that the temperature sensitivity of the blue-tetrazolium test is ascribable to the presence of traces of glucose in the extracted aqueous humor.

Present study

This communication describes the experimental observations which led to the development of conditions which permit the determination of microgram quantities of corticosteroids in the presence of microgram quantities of glucose. Some additional remarks relative to the sulfuric acid chromogen of aqueous humor are also included.

The presence of as little as 1.0 μg glucose/ml. H_2O could be detected by the Mader and Buck method. The optical density of the solution, moreover, was raised from 0.05 to 0.13 after having been heated at 50°C. for 10 minutes. This observation suggested the possibility that traces of glucose were contaminating the samples of extracted aqueous humor† and were responsible for the observed increase in intensity of color of the blue tetrazolium test on heating.

Since the response of glucose in the blue tetrazolium test is sensitive to changes in temperature, room temperature, unless controlled and reproduced, becomes an ambiguous factor and its fluctuation could lead to nonreproducible results. The fact that the optical density of an aqueous solution of 1.0 μg glucose/ml. was of the same order of magnitude as that of a test sample of aqueous humor, made it necessary to remove all traces of glucose‡ from the chloroform extract of aqueous humor§ or to develop conditions for analysis insensitive to the presence of small amounts of glucose.

Removal of glucose. Attempts to remove microgram quantities of glucose from a chloroform extract of an aqueous solution of the sugar by washing with several portions of water in a separatory funnel were not always successful. The possibility of adsorbing the small amount of water (about 1.3 percent) dissolved in the chloroform extract by means of a drying agent in order to remove the glucose was tried. Anhydrous sodium sulfate, previously heated at 110°C. for two hours, was not consistently effective in removing all traces of glucose.

Analytic conditions under which glucose

* From the Research Department, Wills Eye Hospital. This investigation was supported by a research grant from The National Institute of Neurological Diseases and Blindness, of the National Institutes of Health, United States Public Health Service.

† Chloroform extraction of 0.1-percent aqueous solution of glucose, in a manner similar to that used for aqueous humor, removed traces of glucose.

‡ The separation of the chloroform extract must be done with great care not to entrap or carry down any of the aqueous layer which contains glucose.

§ The possibility that other fat-soluble substances were reacting with blue tetrazolium in the analysis was eliminated by showing that petroleum ether extraction of the residue after removal of the chloroform did not change the results. It was also shown that the addition of 100 μg. of cholesterol to the reaction mixture had no effect.

does not interfere. In view of the demonstrated dependence of the speed of the blue-tetrazolium reaction upon the temperature of the reaction medium, it was thought possible to achieve optimal conditions of temperature at which glucose did not react while the corticosteroids reacted quantitatively. Experimentally it was found that at 20°C. the reaction of blue tetrazolium with corticosteroids* was complete in 30 minutes, while glucose, in concentrations of at least 6.0 μg/ml. gave no reaction under the same conditions.

The intensity of the color produced was proportional to the concentration of corticosteroid, at least as high as 30 ug./ml. For periods of time longer than 30 minutes the glucose solutions developed measurable color, while at lower temperatures the corticosteroid reaction was retarded. At 25°C; 1.0 to 5.0 μg. glucose/ml. gave an optical density of from 0.0 to 0.05.

The modified procedure is as follows:

One ml. or more of pooled aqueous humor is extracted five times with 6.0 ml. of chloroform in a separatory funnel. The chloroform layers are collected in a 125-ml. filter flask and evaporated to dryness under the reduced pressure of a vacuum pump at a bath temperature of 45°C. The residue is mixed with 0.85 ml. 95-percent ethanol, and 0.7 ml. of the mixture is pipetted into a glass-stoppered conical tube. To this is added 0.14 ml. tetramethylammonium hydroxide (one percent), and 0.07 ml. blue tetrazolium (0.5 percent in ethanol). The color is developed at 20°C. for 30 minutes and the optical density measured at 510 mμ. A blank without aqueous humor extract was run simultaneously.

Using this procedure values up to 1.7 μg. of blue tetrazolium positive material was found in 1.0 ml. of normal primary aqueous humor from the eyes of rabbits weighing five to seven pounds.

An associated advantage of this procedure is the fact that the blank values are markedly lower than those obtained with the usual blue tetrazolium tests.

It had previously been reported that the aqueous humor removed 20 minutes after the first paracentesis of the anterior chamber showed an increased response to the blue-tetrazolium test. Under the modified conditions described above, the average increase of five experiments was threefold; the values ranged up to 8.0 μg. of blue tetrazolium positive material per ml. aqueous humor.

Sulfuric-acid chromogen.† Previously it had been reported that the absorption spectrum of the sulfuric-acid chromogen of normal aqueous humor of the rabbit eye possessed a maximum peak at 230 to 240 mμ. It has now been found that the presence of the peak at 230 to 240 mμ was associated with the use of pontocaine hydrochloride as the topical anesthetic. When nembutal or ether was used as a general anesthetic, this peak was absent. Instead, a shallow maximum peak at 265 mμ was consistently obtained with the use of the latter general anesthetic. Apparently the 265 mμ peak was obscured by the relatively high absorption in this range associated with the use of pontocaine hydrochloride in the previous investigation.

Petroleum ether extraction of the residue after the chloroform had been removed did not change the absorption characteristics of the sulfuric-acid chromogen. This indicated that cholesterol, whose sulfuric-acid chromogen has a maximum peak at 320 mμ, similar to that of aqueous humor, is probably absent from the latter.

Summary

The conditions of the method of Mader and Buck were modified to permit the de-

* Cortisone, hydrocortisone, tetrahydrocortisone, tetrahydrohydrocortisone, and corticosterone. The crystalline corticosteroids were generously supplied by Merck and Co.

† This part of the work was done with the technical assistance of Dr. Weimar.

termination of μg. quantities of corticosteroids in the presence of μg. quantities of glucose.

At 20°C. the reaction of blue tetrazolium with corticosteroids was complete in 30 minutes, while glucose, in concentrations of at least 6.0 μg/ml., gave no reaction under the same conditions. The intensity of the color produced was proportional to the concentration of cortiosteroids.

Under the new conditions up to 1.7 μg. of blue-tetrazolium positive material was found in 1.0 ml. of normal primary aqueous humor of rabbit eyes.

Addendum

In recent unpublished experiments designed to determine the penetration of various corticosteroids into the aqueous humor of the rabbit eye, it was noted that with samples of fluid from 0.2 to 1.0 ml. the intensity of the color produced by the blue tetrazolium test did not obey Beer's law. Whether the blue-tetrazolium positive material represents corticosteroids in the aqueous humor is being investigated by paper chromatography.

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Ophthalmic Miniature

The Chief Justice asked Mr. Perlman why an optician could not put a new frame on lenses. Mr. Perlman replied that the optician has to have the axis and he can't tell from the lenses.

Chief Justice Douglas: "Have they any machines which will do it?"

Mr. Perlman: "No, sir. Without the axis the lenses could not be placed in the frames."

In response to other questions from the Chief Justice, Mr. Perlman said that the frames are an integral part of the whole operation and the frame is part of what is necessary to treat the eyes to give proper vision. He also pointed out that lenses have a tendency to rotate in the frame.

(Former Solicitor General Philip B. Perlman argued for the American Optometric Association, Inc., as *amicus curiae*.)

Law Week, Supreme Court, **23**:3215-3216 (No. 34, Mar. 8) 1955.

NOTES, CASES, INSTRUMENTS

PATHOLOGIC STUDY OF BRAIN AND RETINAL TISSUES IN AMAUROTIC FAMILY IDIOCY

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Infantile amaurotic familial idiocy, or Tay-Sachs disease, was first described clinically by Tay in 1881 and was described clinically and pathologically by Sachs in 1887.

The disease is a hereditary cerebromacular degeneration associated with a disorder of phosphatide (lecithin, cephalin, and sphengomyalin) metabolism. These are esters of orthophosphoric acid which are deposited in the central nervous system. In this disease, there is bilateral macular degeneration and central nervous-system degenerative changes due to lipoidal degeneration of ganglion cells of the retina and the entire central nervous system.

Infantile amaurotic familial idiocy occurs almost exclusively in children of Jewish parentage. There is a predilection for females in proportion of 3:1. There is no known treatment for the disease.

While this disease has been well known and recognized for the past 70 years, there have been relatively few cases reported that have been observed clinically first, and then had the findings correlated with the gross and microscopic pathologic findings of the brain and eye. Such is the reason for the presentation of this case.

Figure 1 is a section of the brain, showing vacuolization and swelling of the glial cells. This condition was also observed in the retina.

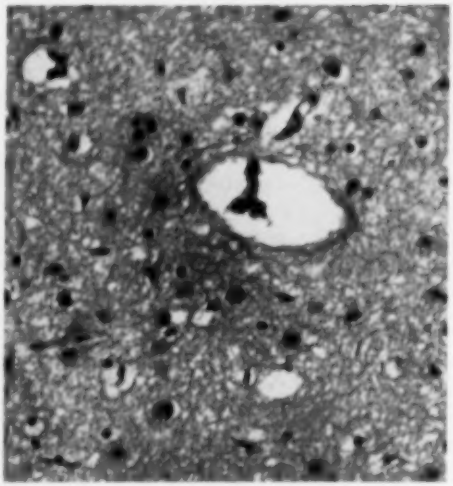

Fig. 1 (Shapira and Leight). A section of the brain, showing vacuolization and swelling of the glial cells.

CLINICAL HISTORY

This one-year-old white Jewish girl entered the hospital, on February 29, 1948, because of convulsions of six hours' duration. The child was blind from birth and mentally retarded. Prior to admission, the child showed numerous twitchings and convulsions.

Physical examination. There were hyperactive reflexes and a positive Babinski sign on the right. There were twitchings on right upper and lower extremities. The tongue deviated to the left.

Laboratory data. The urine showed three-plus albumin and occasional hyaline casts and a few WBC. Hemoglobin was 12.1 gm. (78 percent); RBC, 4,240,000; WBC, 7,330. Color index, 92. Sedimentation rate was 14 with normal plasma color. There were 57-percent polys, 34-percent lymphs, nine-percent monocytes.

Course. The patient had numerous episodes of convulsions and pneumonia with spiking temperatures. The patient's general condition deteriorated and she died at 5:08 a.m. on December 3, 1948.

PATHOLOGIC REPORTS

Brain (Dr. Bucy). The hypophysis ap-

pears rather small but the neural and glandular portions are proportionate. There is a collection of blood lying ventral to the hypophysis inside the dural sheath which may be within a large venous channel.

The entire brain is atrophic. This change is perhaps most marked along the brain stem. The pons is atrophied, there is a deep median sulcus and this continues backward between the two pyramids. The olives are extremely prominent due to atrophy of surrounding structures. The cerebellar hemispheres are both small. The vermis is very small resulting in a very large cisterna magna and the cerebellum is shrunken away from the brain stem.

This atrophy also extends to the cerebral hemispheres; the sulci are deeper than normal and there is definite cortical atrophy. This is most marked over the frontal poles and over the inferior parts of the brain, particularly the temporal lobes. However, it is not limited to those regions. The entire brain feels unusually firm and hard. The cerebellum and brainstem are sectioned serially. They cut with a great deal more resistance than usual. There is considerable cortical atrophy of the cerebellum affecting particularly the superior and medial poles.

The dentate nucleus has a somewhat grayer appearance than usual. This extends to the surrounding white matter.

The optic nerves and chiasm are distinctly smaller than usual and are removed for special microscopic study. The leptomeninges in the region of the cistern ambients and the pineal body are thickened and have a brownish red color as though they had been infiltrated with blood. These tissues are likewise removed for microscopic study. The leptomeninges over the vertex have a somewhat similar but not as marked appearance.

The cerebral hemispheres are sectioned serially and there is a striking change throughout. The cortical gray matter has an extremely white appearance. It is thinner than usual and stands out strikingly against the underlying white matter which, in this brain, is gray in color and has a rather spongy appearance. Furthermore, there is considerable shrinkage of the white matter.

Impression. Amaurotic familial idiocy.

Eye. The following are the eye findings from the specimen submitted to the Armed Forces Institute of Pathology, Washington, D.C.

Gross. The specimen consists of a firm eye measuring 22 by 23 by 22 mm. and an optic nerve with surrounding sclera. The eye is opened in the horizontal plane. There is an opaque rugose fold which completely surrounds the eye at the ora serrata. Engorged blood vessels radiate from the nervehead. The macula is swollen. The lens is in place.

Microscopic. There is a focal abrasion of the corneal epithelium at the limbus on the temporal side. Mild lymphocytic infiltration is observed in the ciliary body. The peripheral retina shows a marked loss of ganglion cells and extreme atrophy of the nerve-fiber layer.

In the macula, ganglion cells are present but present a strikingly abnormal appearance. With the hematoxylin-eosin stain they are large and rounded, with an abundant finely stippled eosinophilic cytoplasm and complete loss of Nissl's substance. Their nuclei are small, round, and pale-staining. With special stains for fat, the cytoplasm is shown to be filled with minute granular lipoidal droplets.

In addition to the large ganglion cells, the fat stain demonstrates many small degenerative cells in which the pyknotic nucleus is surrounded only by a small rim of fatty cytoplasm. No fat is seen in the cells of the nuclear layers, or in the plexiform layers, or in the choroid. The optic nerve is atrophic and the scleral fibers of the lamina cribrosa appear unusually thick and abundant.

Diagnosis. Infantile amaurotic familial idiocy (Tay-Sachs disease).

109 North Wabash Avenue (2).

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HEMIANOPSIA DICHROIC MIRROR DEVICE

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Duke-Elder[1] mentions the benefits of prisms in enlarging the field of vision in cases of homonymous hemianopsia. Bell[2] described a conventional type of plane mirror attachment in 1949 and advocated its use in hemianopsia. He also mentioned the feasibility of convex mirrors for providing a wider angle of reflected field. Personal communication with the manufacturers[3] of hemianopsia mirror visual aids failed to disclose the identity of the original designer.

Dichroic mirrors and filters are an innovation in the field of optics. They are commonly known as "beam splitters." They possess the property of transmitting certain parts of the spectrum and reflecting the remainder with a high degree of efficiency. A wide selection of dichroic mirrors with different transmission-reflection curves is available.[4]

There are two features that recommend these mirrors for use in hemianopsia:

First, the reflected image can easily be distinguished from the transmitted image by the difference in color. This feature would be of particular value to patients with a case of monocular hemianopsia.

The second advantage is the increased size of the reflected field that is obtained by the position of the mirror in the line of sight. The transmitted image is reinforced by superimposition with the image of the opposite eye (fusion).

These two features tend to diminish the confusion of reflected images and thereby allow a greater field of useful vision.

The mirror is placed on the nasal side of the eye homolateral to the hemianopic field. In this position, the temporal field is reflected and the portion of the field that is normally encroached upon by the nasal prominence is utilized without undue interference. Psychologically, the patient appreciates the vision from the "blind" side to be associated with the ipsilateral eye and therefore more readily accommodates to the mirror.

The construction of the hemianopsia visual aid is illustrated in Figure 1. The mirror is mounted in a conventional rim. A sturdy hinge attaches the mirror to the frame of the glasses. The adjustable angle facilitates positioning the mirror to the patient's physiognomy. It allows the patient to select that portion of the reflected field that is considered most desirable. It also permits the patient to fold the mirror against the

Fig. 1 (Duszynski). The hemianopsia dichroic mirror visual aid is mounted for use in front of the left eye. A conventional type of hemianopsia mirror device is mounted on the right side of the frame for comparison.

Fig. 3 (Duszynski). The frontal view illustrates the appearance of the hemianopsia dichroic mirror visual aid in use.

frame for storage or directly forward in the event it is not desired (for reading).

Figures 2 and 3 demonstrate the dichroic hemianopsia mirror visual aid in use. In each of the figures, there is also illustrated a conventional type of hemianopsia mirror attachment for use in front of the right eye (manufactured by The House of Vision).

The advantages afforded to the patient by the use of a hemianopsia mirror are, at best, a compromise. While a certain element of security is gained by the enlarged field, the reversed image is confusing. The clarity of the reflected image allows identification of details but the relative brightness difference between the reflected image and the direct field is occasionally disconcerting. This interference problem can be easily eliminated by simple movements of the head.

Fig. 2 (Duszynski). The profile view demonstrates the hemianopsia dichroic mirror visual aid in use.

A shift in the spectral quality of the light produces relative differences in the intensity of the reflected and transmitted images. This is particularly noted in the shift of the spectrum that takes place from daylight to incadescent illumination. It is also appreciated to a lesser degree under different types of artificial illumination.

In addition, the patient is all too aware of his visual difficulties and dislikes attracting attention by wearing a conspicuous visual aid. However, an intelligent patient who understands the limitations of a dichroic mirror, and is willing to learn to use the device, profits greatly from the practical advantages derived from the increased field of vision that is provided. It should be emphasized that the device is merely a visual aid, as are all optical instruments, and is not intended as a restoration of normalcy.

The choice of a suitable dichroic mirror is purely empirical and is dependent in part upon subjective factors. There are individual variations in color appreciation that greatly influence the usefulness of the dichroic mirror. While one mirror may prove to be entirely satisfactory under a given set of conditions (as in the home), another mirror

may be preferable for use under different conditions (as outdoors). I have found by trial that the red reflecting dichroic mirror, 90-720, is most satisfactory for general use. The optical properties of dichroic mirrors are considered excellent.

1073 Broadway (12).

ACKNOWLEDGEMENTS

The dichroic mirrors and data on specifications were kindly supplied by Mr. Dwight W. Barkley, Liberty Mirror Division of The Libbey-Owens-Ford Glass Company.

The hemianopsia dichroic mirror attachment was manufactured and mounted on the frame by The Bradt Optical Company, 1432 Hertel Avenue, Buffalo 16, New York.

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BAND KERATOPATHY ASSOCIATED WITH RENAL DISEASE*

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Chicago, Illinois

Previous authors have reported a total of 35 cases of band keratopathy associated with disorders of calcium metabolism.[1-4, 6] The most recent is the report of Ojers and Alfano,[2] while the most extensive was that of Cogan, Albright, and Bartter.[3] The diseases involved include hyperparathyroidism, sarcoid, overdosage of dihydrotachysterol, vitamin D poisoning, and renal disease. The last condition comprises the largest group accounting for 25 percent of the total. The present case falls in this group and is presented because of the complete workup, long-term follow-up, and general and ocular pathologic examination which permits a detailed evaluation of the pathogenesis.

MEDICAL HISTORY

B. W., a 51-year-old white man, was first admitted to the Mount Sinai Hospital in March, 1947, with a history of recurrent ulcer symptoms and excessive alkali intake of 25 years' duration. On admission he was in a state of shock, exsanguinated, azotemic, and oliguric. A complete recovery was effected by conservative means except for persistent azotemia, ulcer symptoms, and anemia.

During the next four years, the patient was admitted to the hospital eight times for gastrointestinal bleeding, vomiting, and epigastric distress. Finally, in 1951, the patient consented to surgery and a posterior gastroenterostomy was done because of his poor physical condition, although the medical department recommended a gastric resection. He made an excellent recovery and was well for seven months when he was readmitted with symptoms of angina pectoris. These were relieved by transfusions but later required up to 40 nitroglycerin tablets per day.

Several months later he developed a stomal ulcer which proved intractable. During the last two years of his life, he was admitted to the hospital seven times for his angina and stomal ulcer. The last admission was January, 1953, for an acute myocardial infarct and he died on the second hospital day. Table 1 is a summary of the patient's blood chemistry during the entire course of his illness.

OCULAR HISTORY

He was first seen in the Eye Department in November, 1947, complaining of difficulty in reading. Past ocular history was negative. The patient's mother had bilateral

* From the Department of Ophthalmology of the Chicago Medical School and the Mount Sinai Hospital.

wide-angle glaucoma. Vision, O.U., was correctible to 20/20 and J1. Both corneas showed fine, white, subepithelial deposits adjacent to the limbus and extending two to three mm. into the cornea and confined primarily to the interpalpebral zone. Tension was 22/20 mm. Hg (Schiøtz).

He was seen again in 1948 and 1949, at which times it was felt that there was a slight increase in the corneal pathologic alterations. He did not return to the Eye Clinic until May, 1952.

The calcifications now extended 3.0 to 3.5 mm. into the cornea. The anterior chambers were definitely shallower than on the previous admissions. Vision was correctible in both eyes to 20/20. No conjunctival involvement was noted. There was a deepening of the optic cup and some nasal displacement of the vessels. Tension was 55/45 mm. Hg (Schiøtz). Gonioscopy showed the angles to be open to the pigmented trabeculum over a broad last roll of the iris.

Central fields to 2/1,000 showed early Bjerrum scotomas in both eyes with nasal field loss in the right eye. X-ray studies of the globes showed diffuse calcifications. The tension was fairly well controlled with miotics in the left eye but poorly controlled in the right eye. Scleral rigidity was normal to low on three occasions. Surgery was deferred because of the patient's physical condition, although it was felt a filtering operation was indicated in the right eye.

Pathologic reports

General[6]

The autopsy report of the general pathologic findings was as follows:

Cardiac hypertrophy with multiple recent and healed infarcts. Bilateral polycystic kidneys, arteriosclerosis, and chronic nephrosis. Chronic passive congestion of the lungs with bronchiectasis and bronchopneumonia. Parathyroid adenoma. Chronic stomal ulcer. Functioning gastroenterostomy. Metastatic calcification of the dura, blood vessels, kidney, trachea, and joint capsules.

Ocular[7]

Gross. A slightly distorted paraffin section of a globe. The anterior chamber is very shallow. The retina is detached by artefact from the papilla to the ora. There is moderate excavation of the nervehead. There are several irregular dark-staining areas in the sclera.

Cornea. Epithelium missing near the axial region. Where intact, the epithelium appears contracted; the superficial layers show early keratinization. There are scattered wandering cells among the basal layers. Bowman's membrane is intact. In places, especially peripherally, there are ribbonlike areas of hyalinization. In the stroma are scattered areas of early hyaline necrosis and dystrophic changes. Descemet's membrane and the endothelium are not remarkable.

Limbus. There is a small amount of perivascular round-cell infiltration. The angle meshwork appears sclerosed. There is compression by small peripheral anterior synechias. Canal of Schlemm contains cellular debris and pigment cells.

Sclera. Studded throughout various regions of the sclera, mostly posteriorly, are large hyalinized plaques, some of which have undergone calcification (fig. 1). One such plaque lies parallel to the temporal pars plana. Among these plaques are interspersed round cells, macrophages, and plasma cells in a meshwork of connective tissue.

Lamina cribrosa. Recessed.

Anterior chamber. Decreased in depth and diameter. The chamber is empty.

Iris. There are bilateral peripheral anterior synechias (fig. 1). The anterior border layer is heavily pigmented. The stroma is atrophic and, in places, edematous. Nasally, there are clusters of eosinophils. Bilateral ectropion uvea is present. The posterior pigment layer has lost its pattern and shows early cystic degeneration in areas.

Ciliary body. Thinned and atrophic. The stroma of the processes contains some eosinophils. The ciliary epithelium is degenerated in wide areas. The major arterial circle shows intimal thickening and sclerosis.

TABLE 1

SUMMARY OF THE PATIENT'S BLOOD HISTORY

Determination	Normal[a]	Patient's Range	Usual Values for Patient
NPN	25–35 mg./cc.	39–300	70–100
Creatinine	1–2 mg./cc.	2–11.5	5–7
Chloride (as NaCl)	450–500 mg./cc.	256–500	350–450
CO_2-combining power	55–75 vol./%	52–95	70–80
Calcium (serum)	9–11 mg./cc.	9.7–11.6	10–11
Inorganic phosphorus	3.7 mg./cc.	2–5.8	4–5.5

Choroid. Uniformly thinned and atrophic. Throughout the vascular layers are occasional collections of round cells, eosinophils, and plasma cells. There is moderate sclerosis of the choroidal vessels. The lamina vitrea is intact. The pigment epithelium is bleached in the circumpapillary region.

Retina. Detached by artefact as noted. There is gliosis in the nerve-fiber and ganglion-cell layers. Ganglioform degeneration (inspissated exudates) is present. There is marked sclerosis of the retinal vessels.

Papilla. The nervehead is moderately excavated. The nuclear columns are wholly disarranged.

Optic nerve. There is complete disorganization of the nuclear columns.

Sheaths of the optic nerve. Not remarkable.

Vitreous. Not remarkable.

Lens. Not remarkable.

Diagnosis. (1) Glaucoma, (2) bandform keratitis, (3) calcified plaques in sclera, scleritis, (4) chronic choroiditis, (5) uveal atrophy, (6) uveal and retinal vascular sclerosis, (7) gliosis of retina, and (8) optic atrophy.

Fig. 1 (Folk). Calcification of sclera adjacent to ciliary body and peripheral anterior synechias.

DISCUSSION

This represents another case of band keratopathy associated with renal disease. There is also a history of prolonged alkali intake as was noted in five of the cases reported by Cogan, Albright, and Bartter.

The pathogenesis of this is most interesting—a nephrocalcinosis from a primary functioning parathyroid adenoma. Added to this is further damage from hemorrhage, shock, and dehydration, resulting in functional kidney impairment with azotemia and inability of the kidney tubules properly to retain sodium and chloride (so-called syndrome of salt-losing nephritis). This latter is based upon the observation of the medical department because of their inability to build up blood levels of sodium and chloride even in the absence of persistent emesis and high salt intake (table 1).

The chronic hypochloremic alkalosis was intensified by the patient's alkali intake and chronic vomiting. The chronic alkalosis plus a functioning parathyroid adenoma in the presence of a normal serum calcium and slightly elevated inorganic phosphorus (table 1) resulted in the diffuse calcification in which the cornea and sclera participated because of the tendency toward percipitation of calcium salts in an alkaline media.

25 East Washington Street (2).

I wish to thank Dr. I. Davidson for the general pathologic report, Dr. G. Kara and Dr. M. M. Scheffler for the ocular pathologic examination, and Dr. D. Atlas of the Medical Department for the medical summary and evaluation.

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SERIAL LEVEL PHOTOMICROGRAPHY OF THE EYE*

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AND
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Richmond, Virginia

Serial level photomicrography was developed as an anatomic research tool by Hegre in 1946.[1, 2] By his method, serial levels of tissue embedded in a paraffin block are stained by a special block-staining technique and then photographed under high magnification on motion-picture film. In the motion pictures produced by this method, the structural architecture under consideration remains in accurate registration and constant relative position. As progress is made through the block, the blood vessels, nerves, and variations of the form of tissues are seen to change in shape gradually, thus producing an illusion of movement. A model produced from these serial photographs should represent all structures as encountered in the tissue without distortion and in the proper relationship.

Preliminary studies employing this method have recently been carried out on animal and human eyes at the Medical College of Virginia, and it has been possible to obtain a photographic record of the canal of Schlemm, collector channels, the trabeculum, and other elements of the aqueous drainage channels, undistorted except for changes occurring as a result of fixation. It is hoped that in future studies application of this technique to ophthalmologic problems may add something to our knowledge of the normal and abnormal drainage system of the eye already elaborated by the histologic section studies of many authors[3-16] and more recently by the Neoprene erosion preparations of Ashton.[17] It is further hoped that films so produced will be of value in teaching microanatomy of the eye to students.

The stain technique involves fixation with 10-percent formalin followed by immersion of the tissue segment in 80-percent lead acetate for 24 hours. This is followed by ordinary paraffin embedding technique. The block thus prepared is then aligned on a special microtome in the desired plane of sectioning. By means of special apparatus the tissue block is then sectioned at any desired thickness, immersed in 10-percent aqueous sodium sulfide solution for a constantly measured length of time, then raised from the staining solution, dried by suction apparatus, brought into position, and photographed automatically.

The resultant pictures reveal the structures under study stained a golden-yellow to brown color. Certain tissues, such as the cornea, sclera, trabeculum, pigment endothelium, blood vessel walls, and muscle tissue, exhibit an apparent selective staining character. The stain is distributed, however, down to the intracellular level, thus making possible high-power studies at the cellular level. The technique has its greatest value, perhaps, at the tissue level in which structural architecture is vividly demon-

* From the Departments of Ophthalmology of the Medical College of Virginia and McGuire Veterans Administration Hospital, and the Anatomy Department Medical College of Virginia.

This study was supported in part by the Snyder Ophthalmic Foundation.

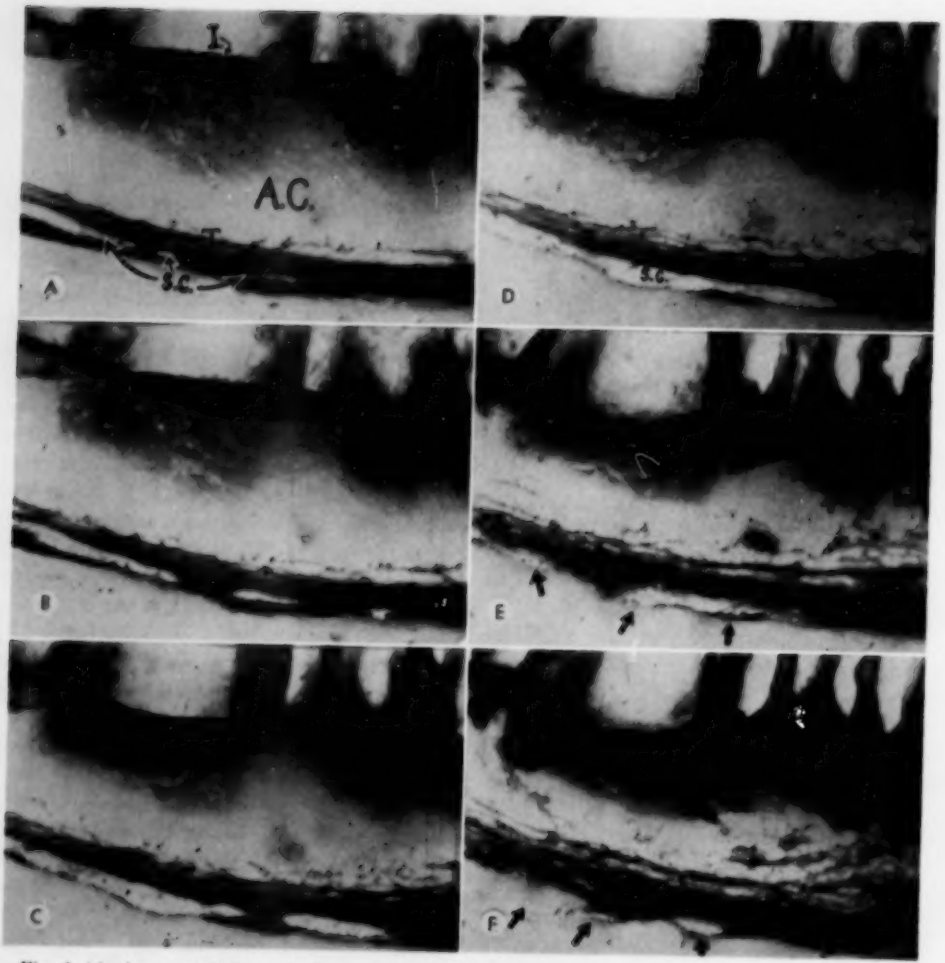

Fig. 1 (Arrington and Guerry). This series of six photographs was copied from 16-mm. Kodachrome motion picture frames. It represents succeeding levels from anterior to posterior in frontal plane of an eight months' (approx.) human fetus eye. The segment is from the inferior limbal region.

A. The iris (I) is seen with the beginning of the anterior ciliary processes above and with the anterior chamber (A.C.) below. Inferiorly, the trabeculum (T) extends across and, beneath it, Schlemm's canal (S.C.) is being entered at several points.

B. Progress posteriorly shows Schlemm's canal to be in the form of an undulating tube.

C. Further opening of the lumen is apparent.

D. The canal extends further and strands of trabecular tissue begin to span and fill the angle recess at the upper right.

E. The posterior edge of Schlemm's canal is continuous with collector channels.

F. The two channels at the right anastomose and these, along with the third central channel, assume the shape and character of blood vessels and progress outward through the sclera.

strated. Studies thus far have been conducted on dog, rabbit, and mouse eyes, in addition to normal human fetus at five and seven months, and a normal adult human eye.

In the preliminary studies carried out so far, eyes have been sectioned into 16 parts, each representing a boat-shaped segment with its apex at the center of the cornea and extending back meridionally to the equator.

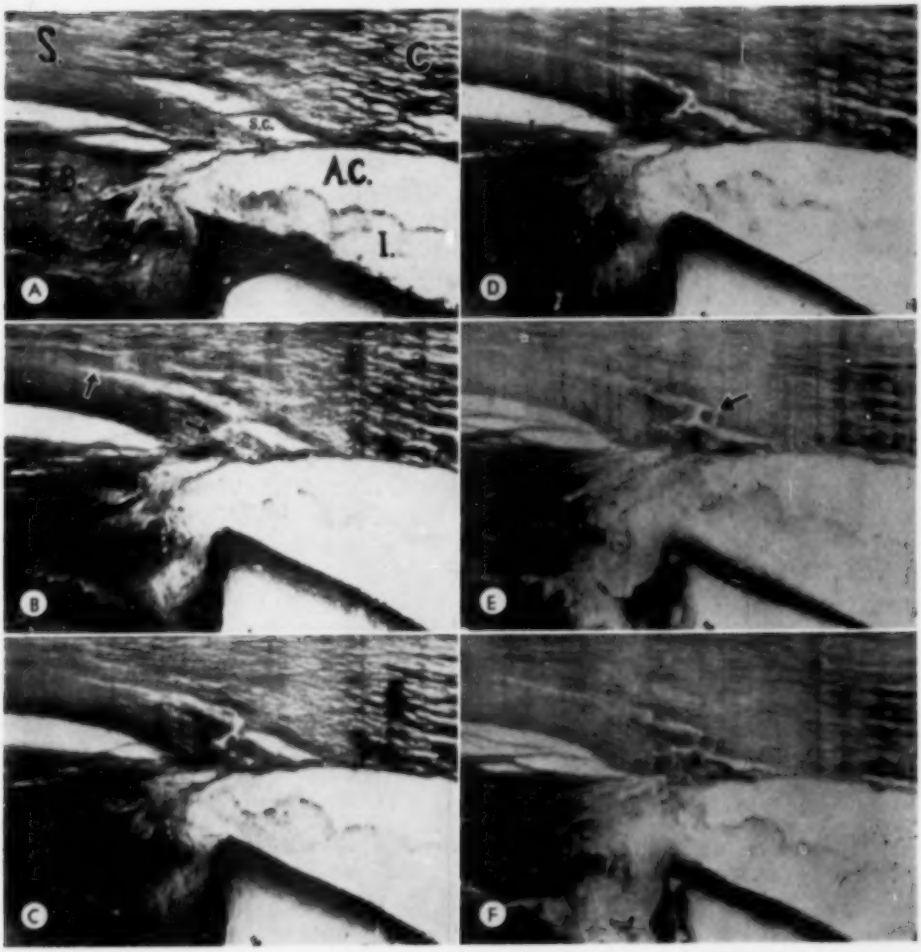

Fig. 2 (Arrington and Guerry). This series of six photographs is representative of succeeding levels through the region of the anterior chamber drainage angle. The plane is parasagittal. The pictures were copied from 16-mm. Kodachrome frames producing some loss of definition (normal adult human eye).

A. The sclera (S) and cornea (C) are seen in the upper half of each frame. Schlemm's canal (S.C.) appears as an elliptic white space bordered below by the trabeculum (T). There is an artefact separation of sclera from the ciliary body (C.B.). The anterior chamber (A.C.) extends into the picture from the right with iris (I) below.

B. In the region of the scleral spur an arrow indicates a blind pocket, and to the left of this a second arrow indicates the extent of a deep scleral vessel.

C. At this level, continuity with the blind pocket is established.

D. An opening with the main channel appears around a central tissue island.

E. At this level the tissue island is larger and two distinct collector channels are seen.

F. The collector channels are disappearing at this level, and Schlemm's canal is reassuming an ellipsoid shape.

These boat-shaped segments have then been prepared as described and sectioned both frontally and sagittally (figs. 1, 2, and 3).

In the frontal plane, when viewed as a motion picture progressing from anterior to posterior through the cornea, the trabecular tissue is seen to thicken as a dark line adjacent to the anterior chamber. Immediately

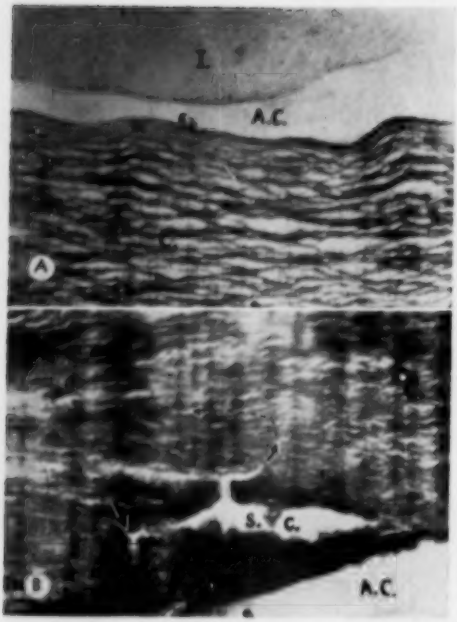

Fig. 3 (Arrington and Guerry). A. This is a frontal section of normal adult human eye. The iris (I) is above. In the original photographs the character, shape, paths, and relationships of vessels, stromal fibers, membranes, can be observed. The cornea (C) extends across the lower half of the picture with the anterior chamber (A.C.) above. The stromal fibers are evident as are Descemet's membrane (D) and the dark condensation representing the endothelium (E).

B. This is a high-power view of Schlemm's canal (S.C.) showing the exit point of a collector channel. The path which this vessel is seen to traverse at subsequent levels is indicated by the arrows. A blind pocket opening is seen to the left of Schlemm's canal.

following this a clear, open band appears across the screen. This represents the most anterior edge of the canal of Schlemm. Collector channels from the canal of Schlemm can be observed as the film progresses and the integrity of the endothelium of Schlemm's canal can be followed. Blood vessels of the iris are evident and the form of other structures (such as iris processes and lens) can be easily followed. In the sagittal view, the canal of Schlemm is seen as an elliptical whitish slit in the corneoscleral junction region, and collector channels are periodically demonstrable as they connect with the upper (that is, external side of the canal.

Summary

This paper presents a preliminary report of the application of a new technique of anatomic study known as serial level photomicrography which utilizes a modified block surface stain developed by Hegre as it applies to the anatomy of the eye. By this means, color motion picture photographs in sequence and at levels of any desired depth can be produced to reveal minute anatomic and histologic features of the eye.

2015 Monument Avenue.

Authors' note

Since preparation of this paper the development of a newly designed sectioning device with angulated knife has eliminated several technical difficulties, such as fraying of tissue and the vertical striations seen in several of the illustrations.

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SOCIETY PROCEEDINGS

Edited by DONALD J. LYLE, M.D.

COLLEGE OF PHYSICIANS OF PHILADELPHIA

SECTION ON OPHTHALMOLOGY

March 18, 1954

DR. EDMUND B. SPAETH, *Chairman*

KRÖNLEIN ORBITOTOMY FOR NEUROMA OF OPTIC NERVE

DR. EDMUND B. SPAETH, The Wills Eye Hospital, presented a motion picture and said:

In considering surgical therapy of orbital neoplasms the surgeon must frequently make a difficult decision: Should the operation be an external orbitotomy by the ophthalmologist, or should the patient be operated by a neurosurgeon through a tranfrontal craniotomy and the orbit entered via the roof of the orbit in the frontal cranial fossa—a so-called uncapping of the orbit?

This consideration is not a part of the present motion picture which is presented to illustrate the easily carried out surgery for an optic-nerve neoplasm through an orbitotomy. It is quite proper to say that a transfrontal craniotomy for this condition is wholly unnecessary. It is true that, while a transfrontal uncapping of the orbit seldom is fatal, it is frequently complicated by subtotal to complete oculomotor paralyses, including ptosis. A far greater incidence of this complication occurs with the craniotomy.

Recently, in carrying out the technique of a Krönlein orbitotomy, surgeons have been using an oscillating saw for the bone wedge resection. While there is no difficulty with this saw, it should be stressed that a simple brace and bit and Gigli saw are equally satisfactory, with no increase in tissue trauma, and these, for the occasional operator, are much less expensive.

A T-shaped incision is made, the T lying upon its side with the cross line curved to parallel the rim of the orbit. The periorbita is loosened from the bone at the rim of the orbit and detached with a blunt periosteal elevator well into the depths of the orbit on the lateral wall. It is a simple matter to carry this blunt dissection down to the lateral lip of the superior and inferior orbital fissures. With a brace and bit (hand driven is adequate) the lateral orbital wall is perforated at the base of the lateral angular process and at the base of the zygomatic process, where it takes off from the zygoma itself. The rim of the orbit is cut through with a Gigli saw threaded through these perforations, and the bone wedge resection completed with a mallet and chisel. The orbit is then entered through a lateral, horizontal, incision in the periorbita, the lateral rectus muscle identified and the intraorbital surgery necessary carried out with full and adequate visibility.

In the instance shown in the moving picture the tumor of the optic nerve was exposed, and a neurectomy of this was performed within the muscle cone without damage to any of the muscles. The cornea of the eyeball was then strongly rotated into adduction so that the optic nerve and the neuroma were in full view, making a resection of the nerve from the globe a very simple procedure.

The incision is closed in the periorbita after careful hemostasis, the wedge of bone is elevated to its normal position and sutured in place with 3-0 chromic catgut through the periosteal edges, the fascia, orbicularis fibers, and the lateral raphe of the orbicularis and closed with catgut, and the skin is closed with black silk. The wound is dressed with the same type of pressure dressing one would use for a fractured orbit.

EXPERIENCES WITH DIAMOX IN GLAUCOMA

Dr. Irving H. Leopold, Dr. I. J. Eisenberg, and Dr. Jules Yasuna said that a car-

bonic anhydrase is an enzyme which interacts with bicarbonate to liberate carbon dioxide and water. This enzyme can facilitate the reaction in the reverse direction. There is evidence that the enzyme carbonic anhydrase exists in ocular tissues, such as the lens (Bakker), iris, choroid and retina (Leiner, 1943), and ciliary body (Wistrandt, 1951). Diamox is a carbonic anhydrase inhibitor that has received considerable usage as a diuretic. At present it is under wide-scale investigation for its possible ability to lower intraocular pressure (Becker, Thorpe, 1954).

This agent has been tried at the Wills Hospital in 51 patients, representing 90 eyes with a variety of glaucomas, all of which had been uncontrolled by miotics and/or surgery prior to the use of Diamox. In this series, Diamox in dosages ranging from 125 to 1,000 mg. per day, lowered intraocular pressure in eyes with narrow-angle glaucoma and wide-angle glaucoma; in eyes with glaucoma secondary to cataract extraction or uveitis, in pigmentary glaucoma, glaucoma capsulare, and in infantile glaucoma. It had its smallest degree of success in glaucoma secondary to venous occlusion and glaucoma associated with rubeosis irides diabetica. It was initially successful in less than 50 percent of the cases of glaucoma associated with traumatic hyphema.

The beginning of the action following the instillation of the drug could be noted as early as 30 minutes after an oral dose. The duration of effect varied in the individual eyes from two to 12 hours following a single dose. Not all eyes which were benefited initially continued to benefit over a three-month period of observation. Some were no longer effectively controlled by Diamox plus miotic therapy. However, there were 16 eyes in this series with varieties of chronic glaucoma, previously uncontrolled by various surgical procedures and various miotics, which have now been controlled by miotics plus Diamox for over three months.

Diamox has some undesirable side reactions. Approximately 75 percent of the patients noted parasthesias of the hands, feet and/or face. Approximately 25 percent were drowsy. One patient was disoriented and 10 percent of the patients had gastrointestinal symptoms including anorexia, nausea, and vomiting and occasionally diarrhea. Ten of the patients refused to continue the drug because of these side reactions. No case of agranulocytosis or skin reaction was noted.

The mechanism of the ocular action of this drug is not known. Other diuretics such as Thiomerin, a mercurial diuretic, will produce a fall in intraocular pressure. This was noted in 10 normal patients. The time of onset of the pressure-lowering effect was much longer after the administration of Thiomerin than after Diamox.

Tonographic studies done on most of these patients have demonstrated no change in the coefficient of aqueous outflow after the administration of Diamox. This suggests that there is a decrease in the formation of intraocular fluids. Paracentesis done on experimental animals revealed that prior administration of Diamox increased the time required for the restoration of the intraocular pressure and for reformation of the anterior chamber as compared to eyes in animals without Diamox. This is additional evidence that Diamox interfered with formation of intraocular fluids. In six patients, it was noted that positive water-provocative tests could be rendered negative by the ingestion of Diamox.

The administration of two to three gm. of sodium chloride or two gm. of sodium chloride and one gm. of potassium chloride to patients on Diamox therapy ameliorates most of the side reactions such as drowsiness, numbness, and tingling. However, the intraocular pressure previously controlled by miotics and Diamox was no longer controlled when the sodium chloride or potassium chloride was added to the therapy.

Because carbonic anhydrase might be playing a role in the active transfer of bicarbonates across the blood-aqueous barrier and into the aqueous humor, it was felt ad-

visable to measure the bicarbonate levels in the rabbit eye and blood before and after the administration of Diamox. These measurements were determined at intervals of one, three, six, and 15 hours after injection of Diamox intravenously (Green, Capper, Bocher). The values obtained revealed that the bicarbonate of the blood plasma fell below normal levels in one to six hours; whereas, the aqueous-humor levels of bicarbonate were normal at one hour but had fallen by the sixth-hour determination. Both the blood plasma and aqueous humor returned to normal levels by 15 hours. The relative drop of bicarbonate in the blood was much greater than that in the aqueous. Not all of the rabbits showed a drop in intraocular pressure.

This question was approached in another manner in which the carbonic anhydrase activity of the ciliary iris tissue was determined before and after Diamox administration in a Warburg apparatus, and the data demonstrated a marked inhibition of carbonic anhydrase activity of the ciliary and iris tissue within one hour after the intravenous administration of Diamox.

Although this data indirectly suggests some influence on carbonic anhydrase activity in the eye, there are other possible mechanisms by which this drug can be acting. It may be altering the pH of the ocular tissues; for example, ciliary body, vitreous. The drug may be producing secondary effects, such as the stimulation of some hormonal substance from one of the endocrine glands. It is known that diuresis may stimulate the formation of pituitary antidiuretic hormone. This hormone theoretically would tend to elevate intraocular pressure, but other mobilized hormonal substances might have a tension-lowering effect. No evidence could be found in these patients for any alteration in scleral rigidity that could be attributed to Diamox therapy.

Discussion. DR. HAROLD G. SCHEIE: Each generation of physicians regards his own age in medicine as the golden one. I believe, however, that my own has been particularly favored. When I was an intern, sulfonamides were first introduced. Since that time, chemotherapy has achieved its present status and antibiotic therapy has been even more miraculous. Hormonal therapy has been equally astonishing. Now, apparently, we are witnessing still another startling advance in the clinical application of our knowledge of the physiology of respiratory enzymes.

When a resident, assisting with some of Dr. Adler's studies on aqueous physiology, theories as to the mechanism of formation of aqueous were much more nebulous than today. Duke-Elder favored the theory of dialysis, but in this country, Adler, Friedenwald, Kinsey, and others were not convinced that secretion was not at least an important factor in its production. Friedenwald developed his reasoning to the point where he suggested that secretion of aqueous by the ciliary body was linked to certain respiratory enzymes. The effect upon ocular tension, which results from the effect of Diamox in inhibiting carbonic anhydrase, seems to support such reasoning.

As Dr. Leopold has said, there is as yet no final proof as to how Diamox (carbonic anhydrase inhibitor) exerts its effect, but it certainly seems to diminish aqueous production. We are carrying out investigations along somewhat the same lines as the present authors. Our observations seem to bear this out, as did Becker's. Our clinical results are quite parallel to those of Dr. Leopold, although recorded on a smaller number of patients observed for a relatively short period of time; however, I believe our results are even more uniformly good. We have noted almost invariable reduction in ocular tension to normal except in absolute glaucoma.

However, some reservations must be maintained. I have talked, in the last two days, to Dr. DeVoe and his group in New York. They have found that patients with simple glaucoma usually develop a resistance to Diamox after two or three months, and the tension rises once more. They believe that its usefulness will be chiefly as an adjunct to

tide the patient over acute phases of glaucoma. This would seem of importance in acute congestive glaucoma and in certain secondary glaucomas, for example that associated with traumatic hyphema where we have noted excellent results. They have also encountered cutaneous reactions to Diamox, as might be expected with sulfonamide therapy. We have had two patients with renal symptoms of calculi. This may have been coincidental, or it is possible that calculi, present beforehand in the renal calices, fragmented when the pH changed from acid to alkali, and became dislodged to cause ureteral symptoms.

Another brief thought which gives me some pause is that we are substituting what may apparently be one abnormal state for another by markedly diminishing production of aqueous. We all know, for example, that cataracts can develop when aqueous formation is reduced and nutrition of the lens is poor, as in the phthisical eye. Until more information is available, it seems advisable to employ Diamox with some caution, probably where conventional methods have failed.

Dr. I. S. Tassman: Would it be advisable at the present stage to use Diamox in routine office practice outside the hospital?

Dr. Irving H. Leofold: I want to thank Dr. Scheie for adding to this presentation. It is possible that this drug may have other toxic features. Dr. Scheie mentioned allergic skin reactions, and the possibility of interference with normal ocular tissue metabolism by virtue of reduced ocular fluid formation. The lens has been shown by Barker to contain a great deal of carbonic anhydrase. Perhaps Diamox will be able to penetrate through the lens capsule to inhibit the carbonic anhydrase in the lens. If so, it might interfere with this metabolism directly.

I can see no objection, Dr. Tassman, to the ophthalmologist using Diamox in his office if he is familiar with the side effects and contraindications of the drug. One should be familiar with the renal status of the patient before applying any diuretic agent and have information of his salt intake prior to the administration of the drug as well as his idiosyncrasies and hypersensitivity, if any. Many cardiac patients have been carried on this drug for a year and a half to two years without untoward results.

Radioactive phosphorus in tumor diagnosis

Dr. John Erbaugh: While it is readily apparent that lesions of the anterior part of the eye may be detected in vivo, we do not feel that anything conclusive can be stated about posterior lesions. The problems involved in the detection of a lesion farther from the counter than the maximal range of beta radiation are not, as yet, solved. Further, the ciliary body interposes a radioactive screen that would further reduce the sensitivity of the test. Although in our 20 cases of detachment, the phosphorus studies have agreed with the clinical diagnosis, it is probable that the large size of the lesions was responsible for their detection by a radiosensitive counter.

Discussion. Dr. J. Eisenberg: Since Thomas first recorded the use of radioactive phosphorus in the detection of intraocular tumors, we at the Wills Hospital have performed a P^{32} concentration test on approximately 200 patients. From the observations that were made on these patients we came to certain conclusions:

1. There is no normal range for P^{32} concentration.

2. If we can establish the normal point of reference, an intraocular neoplasm can be detected. This we have done.

Bettman recently reported that certain areas of the globe show a significant variation of P^{32} concentration, especially if placed over the external muscle. We, too, have found this to be an obstacle. This was overcome by establishing our reference point at the limbus and avoiding any count over the medial rectus muscle near the canthus in the pathologic eye. The other external muscles do not appear to affect our criteria for a positive concentration of P^{32}.

3. We were also able to show that, if the lesion would concentrate P^{32} 30 percent or more than the average in the normal reference point, the test should be considered positive.

Now using this percentage, we ran into one major difficulty. An inflammatory lesion, especially if active, would also give a percentage uptake of over 30. This left the problem of trying to differentiate between inflammatory and neoplastic types of lesion.

Based on some of the work done by Jones in 1940 and reported in the *American Journal of Cancer*, it was felt that neoplastic tissue would retain phosphorus for a longer period of time than corresponding normal or even inflammatory tissues. Working on this hypothesis, we ran a time curve and, much to our gratification, we were able to show that tumors in the eye will show in one hour a 30 percent or more increase, as compared with the average in the normal eye, and that in 24 hours that average will show an even greater increase. In inflammatory lesions there was a fall in the 24-hour uptake. This enabled us to differentiate malignant from inflammatory lesions in the area accessible to our counter. At the present time this test is not reliable for lesions in the posterior segment.

Even though we feel that this test has great value it still has certain limitations. These are: (1) In a one-eyed individual; (2) when both eyes are pathologic; (3) in making counts over the medial rectus muscle near the inner canthus.

Dr. Howard Bedrossian: There is no need to re-emphasize what has already been said. However, I would like to mention a few things that are frequently omitted in discussing the technical difficulties encountered when performing this test. At the Graduate Hospital we have had 30 cases, of which two showed a positive uptake. The remaining cases all showed negative results. Two of our negative results were in patients who had posterior lesions. Although the P^{32} studies were negative, clinically the patients were thought to have a tumor, so the eye was removed. The Geiger counter was then placed directly over the tumor and the previous negative results now became positive, which shows the technical difficulty in getting the counter back far enough in cases of posterior lesions. Our two positive cases were in patients with anterior lesions.

Another problem which arises in evaluating the percentage uptake is in making certain that the readings are not in error. For example, in some patients after the injection of P^{32}, we obtain around 400 counts per minute, whereas in other patients we sometimes get as much as 800 counts per minute. One can easily see that a difference of 50 counts would cause a greater source of error in the first patient with 400 counts per minute, than it would in the second patient with 800 counts per minute. For this reason the person who is performing a P^{32} study must have a great deal of patience, and be willing to repeat the readings over the different quadrants if there is any question about the reliability and consistency of the readings. Theoretically, it should take about four minutes to examine each eye, but there have been many times when I have spent one hour with the patient, repeating the readings until I was satisfied that they were accurate.

As Dr. Eisenberg has mentioned, we, too, have noted a slight increase in the number of counts when taken over the medial rectus muscle. In addition to this, we have noted also the tendency toward increased counts when the readings are taken over the inferior rectus muscle. This may be due to the increased amount of conjunctival tissue in the lower cul-de-sac which comes up around the Geiger counter. Normally there is not as much conjunctival tissue around the Geiger counter when it is placed in the region of the superior or lateral rectus muscles.

It is my feeling that this test will be more reliable if its is performed by the same individual, who would be constantly aware of the possible sources of error.

William E. Krewson, 3rd,
Clerk.

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PERIMETRY IN GLAUCOMA

In the management of primary glaucoma, treatment is based principally on visual acuity, ocular tension, the condition of the nervehead, and the visual field. In angle-closure glaucoma, treatment is guided principally by ocular tension, since any elevation of tension means closure of the angle with the possibility of the formation of peripheral anterior synechias. In this type of glaucoma operation is usually done, therefore, on the basis of elevated tension without waiting for loss of function to occur.

In open-angle glaucoma on the other hand, loss of function is the principal criterion on which treatment is based. The level of ocular tension is important only in so far as it causes loss of function, and the most valuable measure of loss of function is the visual field. Measurements of the visual field tell us

the status of the disease in the beginning of treatment, and subsequent fields tell us whether or not our treatment is effective. To be sure, in some cases of open-angle glaucoma, operation is done just as in angle-closure glaucoma, on the basis of high tension alone. As a general rule, however, the change from medical to surgical treatment in open-angle glaucoma is made on the basis of progressive loss of field. If this is true, then the technique of perimetry and the interpretation of the visual field assume considerable importance.

From experience in consultations and with examinations of the American Board of Ophthalmology it has seemed to me that, from a practical standpoint the teaching of perimetry in glaucoma leaves much to be desired.

Instead of the valuable procedure it should be, perimetry if not done and interpreted in a practical manner may be of little value. The first error that comes to mind is a lack of correlation of the visual field with the status of the optic disc. If the disc is completely normal with no ophthalmoscopic evidence of cupping or atrophy, there can be no important field defect due to glaucoma. This is not to deny that in such cases, if quantitative perimetry is done, some small defect can occasionally be found, but if the diagnosis of glaucoma is established, of what practical importance are these slight defects occasionally discovered by quantitative perimetry?

Again, if the tension is considerably elevated at the time of perimetry, various field defects may be discovered in the presence of a completely normal disc. These defects may disappear completely when tension is normalized, but may be permanent if tension remains elevated for a considerable period. In the latter case, atrophy of the nervehead with or without cupping ultimately develops. In this sort of situation treatment will probably be guided by the ocular tension rather than by the status of the visual field, and therefore field defects in cases with considerable elevation of tension and normal discs are of little importance. From a practical standpoint then, I would offer the dictum as far as glaucoma is concerned of "no disc changes, no field changes."

If the glaucoma is relatively early and the disc shows limited cupping, the location of any field defect can be accurately predicted by inspection of the optic disc. If, as is so often the case in early glaucoma, cupping is confined to the lower outer pole of the disc, the field defect, if any, must be an upper nasal step or an upper Bjerrum scotoma or both. In such cases there can be no glaucomatous defects in the lower field if the upper portion of the disc is normal.

Yet the majority of candidates in American Board examinations when asked the following question answered in the negative: "In a case of glaucoma, if a dense *Bjerrum* scotoma is present can you tell from examination of the optic disc whether the scotoma is in the upper or in the lower field?"

In cases of total cupping of the disc, of course no accurate prediction can be made as to the extent and location of field defects.

In the perimetry of glaucoma, the use of small test objects such as 1/1,000 or 1/2,000 white or even larger objects with reduced illumination is, in my opinion, impractical. That is not to say that, given an intelligent co-operative patient, glaucomatous defects cannot be discovered earlier by these quantitative methods. As a general rule however, field defects discovered by such methods are not accurately reproducible. Too often the co-operation of the patient is not good enough for quantitative perimetry to be reliable.

If tiny test objects are used, lens opacities can cause field defects in otherwise normal eyes, and in glaucomatous eyes can cause considerable exaggeration of existing field defects. If there is extreme miosis, peripheral constriction of the field may be found, due to the miosis itself.

An uncorrected high refractive error may

also be a misleading factor in quantitative perimetry. I have seen several patients in consultation who allegedly had progressive field loss from glaucoma as measured with 1/1,000 or 1/2,000 white objects and who were found by all tests, including tonography, not to have glaucoma at all.

If then, as I believe, perimetry in glaucoma patients done with tiny test objects or with reduced illumination is often inaccurate and misleading, and is tiring to both patient and examiner, then the average ophthalmologist should not employ such methods.

Perimetry in glaucoma is done principally to decide whether or not to change from medical to surgical treatment. Such a step is not to be undertaken lightly. If one is to change from medical to surgical treatment on the basis of loss of field, the field defect should, I believe, be quickly and accurately reproducible with a test object three mm. or larger in size.

As a practical matter, therefore, in the perimetry of glaucoma, I believe a three-mm. object at 33 cm., or one meter is small enough. For many older patients, especially if lens opacities are present, or the pupil is quite small, a five- or 10-mm. object is most practical. Indeed with some unco-operative patients, a confrontation field is the only reliable field.

In some training centers residents are taught to commence the field examination in glaucoma patients with a 1/1,000 object. This would seem to me to be like examining the bark of a single tree without first inspecting the whole tree, or indeed the forest itself. A quick confrontation field will often locate the field defect. This is followed by a test with a 10-mm. object as a further guide to the important areas of defect. Then the field to be recorded is measured with a five or three-mm. object or, on rare occasions, with a smaller object if the patient is intelligent and co-operative.

Which is more important, the perimeter or the tangent screen in the perimetry of glaucoma? I believe both should be routinely used and the results correlated.

Perimetry in glaucoma is best done by an ophthalmologist. The technician, no matter how well trained is handicapped by not being able to interpret the condition of the optic disc, or to evaluate lens opacities and non-glaucomatous fundus changes which may cause field defects.

How often should the field be measured in chronic open-angle glaucoma? I believe three or four times a year is sufficient. Fields measured much more often than this may show changes within the limit of error, and hence are not of much value in the management of the case.

Perimetry in glaucoma should be an eminently practical matter. It is undertaken to tell the ophthalmologist quickly and accurately whether or not, with tension reasonably controlled, the disease is being held in check. Unless it gives this information accurately, it may be not only unhelpful but actually misleading.

Paul A. Chandler.

WILMER RESIDENTS ASSOCIATION

1955 MEETING

The 14th clinical meeting of the Wilmer Residents Association was held in Baltimore on March 31st, April 1st, and April 2nd. Approximately 300 ophthalmologists from various parts of this country and Canada were registered. An impressive number of scientific and clinical papers, motion pictures, and clinics filled the three days. No formal discussion of the material presented was made but most of the speakers were kept well in line by Dr. Frederick H. Verhoeff's razor-like comments.

The first paper "The pathology of experimental nongranulomatous uveitis," was presented by the retiring professor of ophthalmology, Alan C. Woods and by Jonas Friedenwald, associate professor of ophthalmology. The results of treatment in a series

of patients with a presumptive diagnosis of ocular toxoplasmosis using Daraprim and sulfadiazine was given by the present resident Richard Hoover. A. E. Maumenee, who assumes the professorship of ophthalmology, The Johns Hopkins University, and becomes ophthalmologist-in-chief Wilmer Ophthalmological Institute, in July, 1955, presented two papers, "Keratitis secondary to keratinized upper tarsal conjunctiva" and "Surgical removal of epithelial downgrowth from the anterior chamber." Charles Tillett presented his results with "Lamellar keratoplasty and allied procedures." He reported one case in which a posterior lamellar graft has been carried out.

The increasing interest in obtaining donor corneal material for keratoplasty was reflected in two papers on frozen corneas—"An experimental method of freezing and thawing corneas; Preliminary report," by Lieut. Cmdr. Samuel D. McPherson, Jr. (MC) USNR, and Lieut. (jg) J. W. Draheim (MC) USNR, and "Use of frozen corneal graft," by Charles E. Iliff, Ronald Wood, and David Hollander.

W. J. Knauer, Jr., showed a movie and reported results of inferior oblique recession in a series of cases. Howard Naquin reported on the results of ocular surgery in a series of 63 patients with congenital dislocated lenses. Thomas Manchester's paper on "Advising patients with hereditary eye disease" provoked a stimulating discussion. Dr. Shepard Dunn and Dr. Frank Walsh presented a remarkable case of meningioma of the optic nerve followed for 21 years.

Lawrence T. Post, Jr., reported on the experiences in St. Louis with Thorazine in preventing postoperative vomiting. Again a lively discussion was provoked, with D. F. Proctor, professor of anesthesiology, The Johns Hopkins Hospital, leading the discussion. L. Harrell Pierce reported the results in a series of patients operated on for subclinical retinal detachment. The final paper of the first day was "Selection of three colors for a signal system usable by the red-green color blind" by Louise Sloan and Adelaide Habel.

On Friday morning the session was devoted to various aspects of glaucoma. Eric Linner and Walter Kornblueth reported their experiences with experimental tonography in rabbits. Bernard Becker discussed his experimental work on the effect of Diamox on tonography and aqueous flow. Benjamin Rones reported a series of cases showing the tolerance to high tension in glaucoma and re-emphasized the role of the clinician in handling patients with glaucoma. A report on "The long-term administration of Diamox" was given by Carteret Lawrence, Carl Kupfer, and Eric Linner. Charles Hedges presented a statistical evaluation of cyclodiathermy for glaucoma in a series of cases. Angus MacLean discussed "Corneoscleral trephine with subconjunctival tucking of Tenon's capsule."

The first presentation on Friday afternoon was a case of essential iris atrophy by Jerome Bellet. Albert Snell, Jr., presented his recent work on reactions of the iris to injury produced experimentally.

For the third successive year the current status of the studies on diabetic retinopathy in Dr. Friedenwald's laboratory at the Wilmer Ophthalmological Institute was presented. Gertrude Maengwyn-Davies, Howard Stone, and Jonas Friedenwald presented the material as a progress report. Ronald Wood and Malcolm Bick reported on their work in comparing the influence of parenteral trypsin, cortisone, and heparin on acute inflammation. The remaining two papers, "The detection of threshold signals in the retina," by Richard Fitzhugh, and "Current studies in retinal physiology," by Stephen W. Kuffler were from the Department of Physiological Optics of the Wilmer Ophthalmological Institute.

On Saturday morning Robert Schimek presented a movie demonstrating his technique in treating entropion with a horizontal suture and reported his results with the technique. Herman K. Goldberg and S. W. Bar-

telmez reported on "Congenital ocular abnormalities produced experimentally by nitrogen mustard." A. E. Maumenee showed a motion picture of his technique in surgical removal of epithelial downgrowth from the anterior chamber. Stewart Wolff and Howard Naquin presented a case of epithelial downgrowth in which X-ray therapy eradicated all surface epithelium within the eye.

The meeting was brought to a close in a delightful fashion by one of the annual features—the neuro-ophthalmological clinic by Frank Walsh. As usual, a most instructive and entertaining group of cases was presented.

On Friday evening all members and guests were invited to an informal dinner dance at the Lord Baltimore Hotel. Immediately following dinner, the resident staff of the Wilmer Institute put on their completely imaginary version of the experiences of a patient being cared for by the visiting staff of the Wilmer Institute. The great creative and musical ability of the group made it apparent to all present that there would be a bright future for them—in show business, if not in ophthalmology.

Howard A. Naquin.

CORRESPONDENCE

Symblepharon in pterygium

Editor

American Journal of Ophthalmology:

It is hoped that this observation may be worth printing. No reference to it has been found in the contemporary literature. It does not seem to be widely known at any rate.

Symblepharon is considered a sign of conjunctival disease. It has been noted that symblepharon is present in a very high percentage of patients with pterygium. Its presence indicates that pterygium is a more widespread conjunctival disease than previously believed.

In examining for the condition, the conjunctival sac is anesthetized with pontocaine or a suitable local anesthetic, a lid elevator is placed under the upper lid and the lid elevated. Simultaneously the patient looks down and out. The procedure is only moderately uncomfortable with a co-operative patient.

Normal individuals may have one to three mm. adhesions. This was true in over 50 percent of adults who had no history of eye disease and who were not suffering from severe conjunctival inflammation. Small follicles or papillas could almost always be found in asymptomatic individuals. Over 90 percent of patients with pterygium, observed over a four-year period, were found to have symblepharon extending from the upper inner aspect of the fornix to the corneal position of the pterygium. Less frequently could be demonstrated smaller symblepharon arising in the inferior medial fornix. The symblepharon is usually solitary. Occasionally widespread symblepharon could be found in pterygium but this was too infrequent an occurrence to be considered significant.

In postoperative cases, where success had been attained, the symblepharon did not extend to the cornea.

(Signed) Edward O. Bierman,
Santa Monica, California.

BOOK REVIEWS

Advanced Surgery of Cataract. By Daniel B. Kirby, M.D. Philadelphia, J. B. Lippincott Company, 1955. 254 pages, 138 figures and 22 plates in color. Bibliography, index. Price: $27.50.

This handsomely printed and illustrated book represents the last say of Daniel B. Kirby on the important matter of cataract surgery. We are grateful to Walter J. Maher, M.D., and his skill in assembling and organizing the manuscript left by Dr. Kirby at his death on December 27, 1953. Fortunately the manuscript and the collection of illustrations and plates had been completed and what we have is pure Kirby at its best.

Evidently, the author meant to have this

work supplement and bring up to date his first and exhaustive book on the *Surgery of Cataract* with which all ophthalmic surgeons are familiar. In spite of his comprehensive covering of the subject in his first book he had still very much left to say about a matter that concerns us all.

Although repetitive, sometimes to the point of exasperation, Kirby's writings reflect the work of a lifetime of deep thought, contemplation, successful experience, and experiment in his chosen field. As such they demand great respect and attention. If this is given, the reader is heavily rewarded, for here lies exposed his greatest contributions to successful surgery of the opaque lens. These briefly summarized are:

a. The elevation of the corneal flap, a maneuver that startles and even horrifies the conservative surgeon. Yet Kirby, by his experience and honesty, has shown that this procedure is not only without danger to the cornea but assists the calm surgeon in the appreciation of sure and certain technique in what he intends to do. It permits us to do a more careful iridotomy, or iridectomy, a more certain application of forceps or erisophake, the removal of blood clots and the aspiration of sero-sanguineous fluid from the anterior chamber, and, most important of all, the avoidance of trauma by these maneuvers to the endothelium of the cornea.

b. The direct separation of the individual fibers of the zonular bundles, in certain circumstances, from the lens capsule.

c. The use of curare in akinesia and anesthesia.

They are all original and valuable, although many of us are not as yet converted to any or all of these important contributions.

A fascinating thing about cataract surgery is that each surgeon is certain in his own mind that the way he does the operation is the only correct one. There is a certain smugness and self-confidence in the remarks of a successful surgeon that are well recognized and always tolerated. Occasionally converts are made but often we are of the "same opinion still." It can be argued that this is a good thing for our patients and ourselves for mutual confidence in the outcome is the most important ingredient of a satisfactory result, more important than are the many variations in technique that are being so strongly urged and so jealously defended.

It is suggested, therefore, that we approach Kirby's book free of prejudices and with unfixed notions and learn what he has to say about the many problems having to do with the cataract and their solutions. What he has to say is always wise and helpful and invariably provocative of thought, and the solutions to the problems that he presents are eminently sound.

This is a grand book, not for continuous reading but for piecemeal digestion, for to read it through in one sitting can be an exasperating experience, distressing to those of us who knew, appreciated, and loved Dan Kirby. Dogmatic assertions, although unconsciously expressed, and multiple emphasis, reiteration, and repetition can be irritating to the point of blockage. To read and study it through at one sitting is not just to the memory of a great, sincere, honest, and deeply religious surgeon who was so sure that he was right and who has helped us all enormously.

Derrick Vail.

THE YEAR BOOK OF THE EYE, EAR, NOSE, AND THROAT (1954-1955 series). Edited by Derrick Vail, M.D., and J. R. Lindsay, M.D. Chicago, The Year Book Publishers, 1955. 461 pages, 118 illustrations. Price: $6.00.

The recent advances in ophthalmology revealed by the present *Year Book* are most heartening. The retinopathy of prematurity, now proved to be the result of misguided management, will soon disappear in the same limbo of medical history as dinitrophenol cataract and other iatrogenic diseases. An editorial in the February issue of

the *Journal of Pediatrics* bluntly states: "The conclusion is obvious that discriminate and limited use of oxygen in premature infants is now mandatory."

Evidence is accumulating that synergism between the thyrotropic hormone and the adrenocortical steroids is a chief factor in the causation of progressive malignant exophthalmos. Diamox is certainly the most significant medical adjuvant in the care of glaucoma since the introduction of miotics. The effect of isoniazid in early cases of ocular tuberculosis is remarkable. As Alan C. Woods remarks, absence of any therapeutic response to combined chemotherapy within three weeks casts doubt on the validity of the diagnosis of ocular tuberculosis.

The bulbar pressure test of Blaxter receives the endorsement of Vail as a useful diagnostic procedure that may yield the first positive sign in early simple glaucoma. It requires the use of the Schiøtz X tonometer which should be more readily procurable in this country. Parker Heath's lucid study of essential atrophy of the iris reveals the mechanism involved and the cause of the secondary glaucoma that supervenes. According to Vail's experience early iridectomy checks the disease. Incidentally the comments of Vail, scattered throughout the book, are as usual most stimulating. In one such comment he advances the interesting hypothesis that the circumscribed form of choroiditis is determined by a localized vascular thrombosis resulting from contact of the vessels with the inflammatory tissue.

James E. Lebensohn.

THE DOCTOR WRITES: AN ANTHOLOGY OF THE UNUSUAL IN CURRENT MEDICAL LITERATURE. Edited by S. O. Waife, M.D. New York, Grune and Stratton, 1954. 175 pages. Price: Not listed.

The editor of this entertaining little volume has made personal selection of various short essays on medical, pseudomedical, and quasimedical subjects which have appeared in the recent literature. There are included such diversified subjects as "Sherlock Holmes as a dermatologist," "Medicine and the Bible," "Medical stamps," "Showmanship in medical teaching," and some 14 other varied subjects, most of which will prove a delight to the medical reader, whatever phase of medical practice may be his principal interest. "An unusual obstetrical case history," by Richard D. Bryant, is an especially clever playlet in which each phrase or sentence is a direct quotation from the works of William Shakespeare deceased.

Although none of the essays deal directly with ophthalmologic subjects and none of the writings of Georg Bartisch, II, have been included, the book is recommended for those who enjoy a good admixture of medical humor and philosophy.

William A. Mann.

ABSTRACT DEPARTMENT

EDITED BY DR. F. HERBERT HAESSLER

Abstracts are classified under the divisions listed below. It must be remembered that any given paper may belong to several divisions of ophthalmology, although here it is mentioned only in one. Not all of the headings will necessarily be found in any one issue of the Journal.

CLASSIFICATION

1. Anatomy, embryology, and comparative ophthalmology
2. General pathology, bacteriology, immunology
3. Vegetative physiology, biochemistry, pharmacology, toxicology
4. Physiologic optics, refraction, color vision
5. Diagnosis and therapy
6. Ocular motility
7. Conjunctiva, cornea, sclera
8. Uvea, sympathetic disease, aqueous
9. Glaucoma and ocular tension
10. Crystalline lens
11. Retina and vitreous
12. Optic nerve and chiasm
13. Neuro-ophthalmology
14. Eyeball, orbit, sinuses
15. Eyelids, lacrimal apparatus
16. Tumors
17. Injuries
18. Systemic disease and parasites
19. Congenital deformities, heredity
20. Hygiene, sociology, education, and history

2

GENERAL PATHOLOGY, BACTERIOLOGY, IMMUNOLOGY

Karli, P. **An experimental study of the pathogenesis of pigmentary retinal degenerations.** Ophthalmologica **128**:137-162, Sept., 1954.

The nucleus of the paper is a retinal disease (retinosis) occurring in certain strains of mice and rats and characterized by gradual melting-away of the outer retinal layers. In mice, the first microscopic signs of the retinosis become visible when the animal reaches the age of 10 days. On the 20th day only vestiges of the outer retinal layers are left. The inner layers do not become involved until several months later. By crossing an affected female with a normal male, the hereditary nature of the retinosis could be demonstrated.

On the assumption that the local mechanism of the dying-away of the visual epithelium is a metabolic disturbance, the author made systematic studies of the effect of the typical inhibitors of carbohydrate metabolism upon the retina of the rabbit and found that one intravenous dose of monoiodo-acetic acid produces a very characteristic retinosis.

The paper closes with a review of the various retinoses produced by experimental means and with a discussion of the possible relationship between these retinoses and pigmentary degeneration in man. (13 figures, 76 references)

Peter C. Kronfeld.

Koch, C. **Microscopic findings in evaporated primary and regenerated rabbit aqueous.** Ophthalmologica **128**:318-325, Nov., 1954.

For a number of years the author has been engaged in microscopic studies of evaporated specimens of ocular fluids. The present paper deals with the differences between primary and regenerated rabbit aqueous which are illustrated by photomicrographs. (9 figures, 6 references)

Peter C. Kronfeld.

Planten, J. T. **The question of intra-arterial obstructive mechanisms in the eye.** Ophthalmologica **129**:57-59, Jan., 1955.

Histologic sections of the posterior sclera occasionally show arterial cross sections which are largely filled by what looks either like loose plugs consisting of endothelium, intima and media or like in-

vaginations of the vessel wall. These formations closely resemble the polypoid pedunculated cushions which Bucciante described in the vessels of the prostatic capsule and considered to represent a physiologic obstructive mechanism. The author of the paper under review made a systematic search for these formations and found them in branches of posterior ciliary arteries in 11 out of 23 cases. Careful histologic study of these formations convinced him that they are artifacts, occurring "through a catapult-like action of the elastic vessel wall during extirpation of the specimen." (3 figures)

Peter C. Kronfeld.

3

VEGETATIVE PHYSIOLOGY, BIOCHEMISTRY, PHARMACOLOGY, TOXICOLOGY

Boles-Carenini, B., and Cambiaggi, A. **The effect of some new antibiotics on the experimental herpetic keratitis of the rabbit.** Ann. di ottal. e clin. ocul. **80**:547-552, Dec., 1954.

Topical instillations of gramicidin with neomycin, erythromycin, chloramphenicol, tetracyclin, magnamycin, and gantrisin were of no value in the prophylaxis and the treatment of experimental herpes simplex in 72 rabbits. (34 references)

John J. Stern.

Capalbi, S., and Venturi, G. **Tetracyclin hydrochloride in ophthalmology. (experimental and clinical studies).** Ann. di ottal. e clin. ocul. **80**:553-574, Dec., 1954.

Tetracyclin hydrochloride in solutions of 0.25, 0.50, and 1 percent introduced directly into the media is well tolerated by the aqueous; the vitreous tolerates the weaker concentrations but the 1-percent solution causes organization of the vitreous fibers and retinal degeneration. A method of microbiologic titration was used to ascertain the presence of the antibiotic in the anterior chamber after systemic administration. Tetracyclin hydrochloride passes easily and rapidly into the aqueous and it stays longer in it than all other antibiotics. In a series of clinical trials, the new antibiotic proved its value in affections of the lacrimal pathways, the conjunctiva, and the cornea when it was applied as a 2-percent ointment which, in more severe cases, was combined with systemic administration. (10 figures, 32 references)

John J. Stern.

Ferraris de Gaspare, P. F., and Maffei, G. **The changes produced by tobacco on retinal and cochlear sensitiveness.** Riv. oto-neuro-oftal. **28**:365-395, Sept.-Oct., 1953.

The authors are studying the effects of tobacco poisoning on retinal and cochlear sensitivity. The results were essentially the same in normal subjects as in the patients with glaucoma. In tobacco-alcohol amblyopia an increase was noted in the scotoma coincident with the tobacco poisoning. No observable change was noted in the tapetoretinal degenerations. (4 figures, 18 references)

Theodore Bisland.

van Heyningen, R., Pirie, A., and Blackwell, J. **Effect of cocarboxylase on the development of galactose cataract in rats.** Brit. J. Ophth. **39**:37-40, Jan., 1955.

In 1954 Hormann reported that all rats fed 30 percent galactose developed complete lens opacities in 45 to 48 days; that all rats fed 70 percent galactose died of toxemia; that rats fed this diet and who were given subcutaneous injections of cocarboxylase (vitamine B_1 pyrophosphate) not only did not develop cataract but easily survived the 70 percent galactose. The results seemed so important that it was decided in this study to repeat the experiments. This was done very carefully but none of the results could be confirmed. There seemed to be no difference in the development of cataract or toxicity in the rats that did and those that did not

receive cocarboxylase. (3 tables, 5 references) Morris Kaplan.

Koch, Carl. **Microscopic findings in amber-colored specimens of subretinal fluid.** Ophthalmologica **128**:129-135, Aug., 1954.

In contradistinction to the usual colorless or slightly yellowish specimens of subretinal fluid which form characteristic crystals on desiccation, amber-colored specimens form such crystals only on the addition of distilled water and redrying. (8 figures) Peter C. Kronfeld.

Maass, L., and Meyer-Arendt, J. **Ultraviolet absorption by senile cataract.** Arch. f. Ophth. **155**:492-495, 1954.

Four normal lenses, six lenses with senile cataract and one lens with cataracta brunescens were spectrophotometrically studied. The normal lenses and the lenses with senile cataract had their maximum of extinction near 2780 Angström's units, their minimum near 3200 A. The maximum of the cataractous lenses was found to be slightly lower, the minimum slightly higher than that of the normal lens. The absorption curve for the cataract brunescens was found to be shifted to the range of much shorter ultraviolet waves. (2 figures, 10 references) Ernst Schmerl.

Michaelson, I. C., Herz, N., Lewkowitz, E., and Kertesz, D. **Effect of increased oxygen on the development of the retinal vessels.** Brit. J. Ophth. **38**:577-587, Oct., 1954.

Controlled experiments with litters of mice in increased oxygen were made. In increased oxygen a delay in the formation of the capillary bed situated round the disc is prominent. The process appears to be inhibition rather than occlusion. Hyperoxia leads to diminution of the number of retinal capillaries especially at the posterior pole. In underdeveloped animals there is a complete absence of capillaries in the retina and the retina appears to be especially sensitive to hyperoxia. Variation in the oxygen content from 40 to 70 percent gave similar results. Newborn animals were kept in hyperoxia for seven days, and then in normal air. The normal capillary pattern is established within a few days after the return of the animal to normal atmospheric conditions. Some capillary buds in the vitreous were found to be remnants of the hyaloid system.

Orwyn H. Ellis.

Michaelson, I. C., Herz, N., and Kertesz, D. **Effect of increased oxygen concentration on new vessel growth in the adult cornea.** Brit. J. Ophth. **38**:588-590, Oct., 1954.

Experiments were carried out to determine if an increased concentration of oxygen in the blood has any effect on the budding of vessels in the adult eye. The tissue chosen was the rabbit's cornea, and the lesion was a standard thermal lesion. No effect on new vessel growth in the cornea of the rabbit eyes was obtained by increasing the percentage of oxygen inhaled. Orwyn H. Ellis.

Miglior, M., and Pirodde, A. **Determination of the proteins in human tears, by electrophoresis.** Gior. ital. oftal. **7**:429-439, Sept.-Oct., 1954.

The authors have found that it is possible, by electrophoresis, to cause a separation on filter paper of the protein fraction in human tears. This method showed that tears contain three kinds of protein, one of which is lysozyme, and the other two probably are globulins and albumins. These three protein fractions are present in about equal quantities. The investigation has also shown that lysozyme is present in considerable amounts in tears. (3 figures, 22 references) V. Tabone.

Odahara, H. **A cardiotonic substance isolated from frog retina.** Acta Soc. Ophth. Japan **59**:257-261, March, 1955.

A cardiotonic substance was isolated from frog retina. The substance appeared when the emulsion of retina was exposed to light for 30 minutes in vitro. The action of the substance was similar to that of epinephrine. It was stable in heat; the potency could be preserved for one hour at 97°C. The substance was not soluble in ether. It was inactivated by hydrolysis with acid or alkaline but was not influenced by urethane, citric acid and pyruvic acid. There was an increase in this substance when glutamic acid, cyanic acid, monoiodo-acetic acid or sodium fluoride was added to the retinal emulsion. The substance was identified as glutamine by paper chromatography. The author assumes that there is a balance between glutaminic acid and glutamine in the retina. When the balance is disturbed an increase in glutamine may result which has a cardiotonic action. (7 figures, 4 references) Yukihiko Mitsui.

Pagliarani, N., and Cavicchi, L. **The action of cortisone on experimental endocrine exophthalmos.** Riv. oto-neuro-oftal. **28**:396-403, Sept.-Oct., 1953.

The action of cortisone was studied on young normal and thyroidectomized guinea pigs. In the normal group, the administration of thyrotropic hormone followed by cortisone produced no exophthalmos. In the thyroidectomized animals, the group (50 percent) which received both thyrotropic hormone and cortisone had a more constant and more marked exophthalmos than those receiving only thyrotropic hormone. Reasons for this action are discussed. (2 tables, 14 references) Theodore Bisland.

Sapuppo, Concetto. **Research on pigmentary degeneration of the retina. B. The influence of electroshock on experimental pigmentary degeneration of the retina.** Riv. oto-neuro-oftal. **28**:432-436, Sept.-Oct., 1953.

The author believes that electric shock (40 volts and 0.5 second's duration) does not alter either the onset or the severity of pigmentary lesions of the retina produced experimentally by sodium iodate. (8 references) Theodore Bisland.

Sapuppo, Concetto. **Research on pigmentary degeneration of the retina. C. The action of retrobulbar alcohol on experimental pigmentary degeneration of the retina.** Riv. oto-neuro-oftal. **28**:437-440, Sept.-Oct., 1953.

The author injected one cc. of 50 percent alcohol retrobulbarly. In the experimentally produced pigmentary retinitis (if pigmentary retinitis can truly be produced by sodium iodate), the alcohol injections had no effect on either the onset or severity of the lesions. (9 references) Theodore Bisland.

Spencer, William H. **Pseudomonas aeruginosa infections of the eye.** California Med. **79**:438-443, Dec., 1953.

The author reviews the literature in detail. It was demonstrated in vitro that polymyxin B was effective against strains of Ps. aeruginosa which on inoculation caused rapidly progressive ulcers in the corneas of rabbits.

Both corneas were injected in a series of rabbits. The treated eyes remained clear. In the rabbits not treated for 24 hours after inoculation, ulcers developed but remained localized during therapy. In those not treated for 48 hours after inoculation, ulcers developed but remained localized during therapy. In those not treated for 48 hours after inoculation, ulcers developed before treatment began but did not spread as rapidly as in the controls.

Hyaluronidase was added to the preparation for half the rabbits in each group but had no perceptible effect. Orwyn H. Ellis.

4

PHYSIOLOGIC OPTICS, REFRACTION, COLOR VISION

Akiyama, K. **Study of surgical treatment of myopia. II.** Acta Soc. Ophth. Japan **59**:294-312, March, 1955.

This is a re-examination in rabbits of the surgical treatment of myopia by Sato. Akiyama states that any radiating incisions of the cornea resulted in the development of hyperopia. He was able to reduce an average 7.4 diopters of refraction by combined (posterior and anterior) radiating incision of the cornea. When the anterior incision was extended to the scleral surface, the effect became less pronounced. Posterior incision alone was less effective. Anterior incision itself was only slightly effective; however, when it was used in combination with the posterior one, the effect of surgery became doubled. Any incision in a tangential direction resulted in the development of myopia. Autokeratoplasty with a trephine showed the extreme effect of this kind. A smaller graft gave a greater myopia. Reoperation of any kind was done without any unfavorable results, when the effect of the first operation was unsatisfactory. (17 figures, 7 tables) Yukihiko Mitsui.

Bonavolontà, Aldo. **Study of the isopters for separative power in the central region of the retina.** Gior. ital. oftal. **7**:394-413, Sept.-Oct., 1954.

The author reviews the literature on the relation of the visual acuity to the topography of the retina. He determined the isopters for the resolving power in the central region, and the relation between these and the structure of the retina at this site. His results, obtained from 50 different persons, are tabulated, and the technique employed is described. (1 figure, 3 graphs, 1 extensive table, 71 references) V. Tabone.

Brueckner, R. **The effect of high altitude upon visual acuity.** Ophthalmologica **128**:389-402, Dec., 1954.

Presbyopes traveling from low to high parts of Switzerland often report better, easier reading vision at high altitudes. In this study the visual functions of 10 elderly (over 65 years of age) and five younger control individuals were measured in Basle, representing the lowlands (elevation 900 feet), and again at St. Moritz (elevation 3600 feet). No significant change in visual acuity or accommodation was observed. A marked positive psychologic effect, euphoria, and improved physical capacity was noted. (3 figures, 2 tables, 4 references)

Peter C. Kronfeld.

Flom, Merton C. **Variations in convergence and accommodation induced by successive spherical lens additions with distance fixation—an investigation. With the description of a clinical method for testing the validity of the refractive correction.** Am. J. Optometry **32**:111-135, Feb., 1955.

This paper confirms recent work in which it was shown that for accommodation to relax, there must be a visible distant object in the field to fix upon. It is important in the fogging method of refraction, since Flom has shown that plus fogging lenses may in some cases stimulate a higher accommodation level than was present without the fog. Measurements of convergence showed that fogging lenses in those cases increase esophoria, which persists on continued use of excess plus lens as long as 30 hours. This work also would throw doubt upon the practice of prescribing excess plus sphere for the treatment of esophoria or esotropia in children. Paul W. Miles.

Foges, G., and Schubert, G. **The masking mechanism of the human eye.** Ophthalmologica **128**:30-44, July, 1954.

The paper is essentially a contribution

to the theory of color vision in man. Specifically, the authors aim to reconcile the results of color photography and color printing, on the one hand, with strictly physiologic facts, on the other. Color photography and color printing have become highly successful at eliciting most color sensations with strictly trichromatic methods, that is by mixing of three pigments representing three, mutually exclusive zones of the spectrum. A good deal of recent physiologic evidence points toward a very different, more complex receptor apparatus. Granit, with his method of selective adaptation has demonstrated five receiving systems with largely overlapping spectral ranges in the retina of the cat. Utilizing electrophysiologic as well as psychologic evidence, the authors of the paper under review elaborate a concept under which the difference between the polychromatic and the trichromatic system becomes a difference of level within the retina. An inhibitional retinal process called masking mechanism is assumed to reduce the overlap and the multiplicity of components to a roughly trichromatic result. The details of the concept do not lend themselves to abstracting in this limited space. (1 figure, 24 references) Peter C. Kronfeld.

Kruemmel, H. **Horopter anomalies.** Arch. f. Ophth. **155**:617-634, 1954.

A new kind of horopter apparatus made by Carl Zeiss was used to examine about 50 normal persons. With the same person, constantly occurring deviations in the horizontal and vertical meridian could be demonstrated. Anomalous positions of the blue and red horopter were found to correspond with displacements of the focal points for blue and red due to chromatic aberration. (25 figures, 6 references) Ernst Schmerl.

Pascal, Joseph I. **Note on two magnification formulas.** Ophthalmologica **128**: 197-200, Sept., 1954.

In calculating the degree of magnification produced in the human eye by an optical instrument one may use as the original (precorrection) image either the clear optical image that in the ametropic eye is situated somewhere off the retina or the blurred image which forms on the retina of such eyes. Different formulas apply to the two situations.

Peter C. Kronfeld.

Rathschüler, Romano. **The accommodation of the myopic eye. (Statistical investigation and clinical deductions.)** Ann. di ottal. e clin. ocul. **80**:537-546, Dec., 1954.

In the myopic eye the accommodation is generally reduced because of an underdevelopment of the ciliary muscle. There is no direct relation between the myopic state and the capability of tolerating the correction for distance during near vision; the relation exists between visual acuity and usefulness of the total correction for close vision. There is no direct relation between the range of accommodation in a myope and his tolerance of the total correction for close vision. Finally, there is no relation between range of accommodation and age in myopia; the range of accommodation does not follow the curves of Donders and Duane. (6 tables, 14 references) John J. Stern.

Sachsenweger, Rudolf. **Depth perception in dim light.** Arch. f. Ophth. **155**:496-517, 1955.

62 normal persons were studied with the help of Helmholtz's three-rod apparatus. The surface brightness in these studies varied from 100 to 0.0001 apostilb. In the German literature surface brightness is usually expressed in apostilbs whereas in the English literature stilbs are used. One apostilb equals $1/\pi \cdot 10^{-4}$ stilb. The results obtained in this investigation varied considerably. However, for average values the following formula

could be arrived at: log T = a · log L + b, (T = depth perception, L = surface brightness, a and b constants). Night myopia considerably affects the depth perception. (8 figures, 60 references)

Ernst Schmerl.

Suzuki, I. **Studies of accommodative convergence.** Acta. Soc. Ophth. Japan **59**: 213-222, March, 1955.

This is a re-examination of the fact that the accommodation-accommodative convergence curve is linear. According to the author's experiment this fact is valid when the measurement is performed by means of a haploscope. When the Maddox rod is used for measurement, the increase of convergence becomes small in the vicinity of the near point. When a pin hole is used, the accommodative convergence becomes small. With a larger test object a greater convergence results. (7 figures, 7 tables, 14 references)

Yukihiko Mitsui.

Weale, R. A. **Theory of the Pulfrich effect.** Ophthalmologica **128**:380-388, Dec., 1954.

A theoretical trajectory of the pendulum bob in Pulfrich's stereophenomenon is developed from the basic assumption that the eye behind the neutral filter (the screened eye), because of its longer latent period, "sees" the stimulus a certain distance back of where the unscreened eye sees it. The intersection of the visual directions of these two horizontally disparate images in front of the plane of the pendulum gives rise to a single impression with the quality of nearness: the pendulum seems to deviate toward the observer. The general expression for the trajectory of the pendulum is an ellipse; it can be made circular by varying the parameters, the excursion of the pendulum, and the distance of observation.

Recent empirical studies of Pulfrich's stereophenomenon by Trincker, reveal an asymmetric trajectory. Some of the factors that may account for the difference between theoretic and empiric trajectory are discussed. (3 figures, 7 references)

Peter C. Kronfeld.

5

DIAGNOSIS AND THERAPY

Barrios, R. R., Vasquez Barriere, R., and Kasdorf, H. **Beta radiation in ophthalmology.** Arch. Soc. oftal. hispano-am. **14**:1231-1244, Oct., 1954.

The D E applicator, and the technique of application are described, and the results obtained in 48 cases of various diseases of the lids, conjunctiva, cornea and sclera are reported. Good results were obtained in one case of hemangioma of the lower lid in an adult. The result was excellent in four out of five cases of vernal conjunctivitis of the lids; in a case of limbal vernal conjunctivitis there was some improvement. There was no effect in a case of dermoid at the limbus. The author uses beta rays in all cases of pterygium in which postoperative corneal vascularization appears probable. Favorable results were obtained in three out of four cases of keratectomy. In a case of herpetic keratitis with dense deep vascularization, a keratectomy followed by radium application increased the corneal transparency, and vision improved to perception of large objects. In three cases of lye burn of the cornea, keratectomy followed by beta radiation, and in one case a perforating keratoplasty in addition, resulted in a visual acuity of counting fingers at one meter. In two cases of lye burn and one of ammonia burn there was no improvement. In three cases of corneal herpes the results were poor, and the author urges caution in the use of radium in herpetic lesions. In two cases of Mooren's ulcer the pathologic process was arrested. The application was effective in resistant cases of episcleritis, par-

ticularly in those of rheumatic origin. (16 figures, 16 references) Ray K. Daily.

Erlanger, Gustav. **Iontophoresis, a scientific and practical tool in ophthalmology.** Ophthalmologica **128**:232-246, Oct., 1954.

"This paper is based on many thousands of (iontophoresis) experiments on animals . . . and derives the recommendations for further studies and practical applications in ophthalmology from an experience of about 30 years and more than, modestly speaking, one hundred thousand (iontophoresis) treatments." No less astounding are some of the author's results. Iontophoresis with calcium chloride (3:1000) and eserine salicylate (0.03:1000), in the amount of 1 mA for 15 minutes, can clear a perfectly cloudy vitreous temporarily so that the underlying fundus disease may be diagnosed. Vasodilators, such as eserine together with acetylcholine, administered iontophoretically, are stated to be effective in amblyopia ex anopsia. Pareses of the extraocular muscles are reported to respond well to iontophoresis with acetylcholine. The author's results in corneal ulcers and iritis are more in line with the general experiences in this field. (36 references) Peter C. Kronfeld.

Evans, P. Jameson. **A corneal needle.** Brit. J. Ophth. **38**:630, Oct., 1954.

The article announces the local manufacture of excellent cutting-point corneal needles. Orwyn H. Ellis.

Foster, John. **Simplified near point rule.** Brit. J. Ophth. **39**:52-53, Jan., 1955.

For measuring the near point of accommodation, the author designed a light-weight rod which can be attached to the trial frame. The rod bears markings of centimeters, diopters, equivalent age and zones of normal or defective near point of convergence. The test object to be used with it is a chart of words of diminishing size. (1 figure, 8 references) Morris Kaplan.

Fuchs, Adalbert. **The complications of the enucleation operation.** Ophthalmologica **128**:114-128, Aug., 1954.

The paper deals more with mishaps due to faulty technique than with the complications of the enucleation operation. The worst mishap is removal of the sound instead of the diseased eye which has occurred more often than recorded in the literature. With regard to the surgical technique, the optic nerve should be severed far back in cases of retinoblastoma, all other intraocular tumors, sympathetic ophthalmia, atrophy of the globe after penetrating injury, and absolute glaucoma with invisible fundus. In highly myopic as well as in very soft eyes, special care should be exercised not to cut into the globe during the sectioning of the optic nerve. Accidental fenestration of the globe may also happen during the tenotomy of one of the rectus muscles. Profuse persistent bleeding from the ophthalmic artery is a true but fortunately rare complication. (8 figures, 26 references) Peter C. Kronfeld.

Gastanera, Alfonso. **Stereoscopic equipment.** Arch. Soc. oftal. hispano-am. **14**: 1245-1249, Oct., 1954.

The author combined in one apparatus a stereoscope, a cheiroscope and a stereodisparator. (2 figures) Ray K. Daily.

Havener, W. H., and Siebert, C. A. **Sterilization of sharp instruments by boiling, with utilization of cathodic protection to prevent corrosion.** Tr. Am. Acad. Ophth. **58**:724-732, Sept.-Oct., 1954.

The authors state that moist heat at 100° C. is more effective than immersion in chemical germicides. The authors also outline the electrochemical concept of corrosion. They state that cathodic protec-

tion has been shown to be completely successful in the prevention of corrosion of sharp instruments during their sterilization by boiling. (2 figures, 1 table, 10 references) Theodore Shapira.

Malbran, Jorge. **A new operation for myopia.** Arch. Soc. oftal. hispano-am. **14**: 1167-1183, Oct., 1954.

The new operation described by Malbran consists of a lamellar scleral resection combined with the implantation of a belt of bovine fascia lata around the posterior portion of the globe, in such a manner that it exerts counterpressure against the tendency of the globe to distend backward. The operation reduces the anteroposterior diameter of the globe, and impedes the distension because of the resistence offered by the belt of fascia lata which adheres closely to the sclera. Malbran considers the risk of this procedure less than that involved in the Fukala operation. The lamellar resection is performed first on the temporal half of the globe. The insertion of the fascia lata belt is begun by isolating the tendon of the inferior oblique, and passing the belt under it. The strip of fascia lata is 6 cm. long, 6 mm. wide, and 0.5 mm. thick. The center of the strip is pushed backward to the posterior portion of the globe and the ends are passed forward to the medial insertions of the superior and inferior rectus muscles. The ends of the belt are held under tension so that it applies itself closely to the posterior portion of the sclera. The ends of the belt are sutured to the sclera with two sutures of 3-0 silk, the upper end at the medial insertion of the superior rectus muscle, and the lower at the medial insertion of the inferior rectus. The author believes that the operation is indicated as a prophylactic measure in young people with grave myopia. The insertion of the supporting belt, without a scleral resection, is advocated for moderate myopia in young children with a family history of progressive or complicated myopia. Twenty brief case histories are tabulated. (1 figure, 67 references)

Ray K. Daily.

Moffatt, Allen B. **Measuring strabismus hooks.** Brit. J. Ophth. **39**:54-55, Jan., 1955.

The use of calipers for measuring in muscle surgery is generally satisfactory but the measurements often result in asymmetric placement of sutures. Since resections are most often 10 mm. long and recessions are usually 5 mm. the author had two muscle hooks modified so that the hook is replaced by a flat piece of steel 12 mm. long and 10 mm. wide in one and 5 mm. wide in the other. The instrument is placed under the muscle at its insertion and with its help symmetrically placed marks are easily made.

Morris Kaplan.

Niesel, P., and Leonardi, F. **Comparative measurements of the retinal arterial pressure with the angiotonometer of Baurmann and the ophthalmodynamometer of Mueller.** Ophthalmologica **129**:22-35, Jan., 1955.

The ophthalmodynamometer of Mueller is a modification of Bailliart's original instrument. A spring-driven piston indents the eyeball wall and thereby raises the intraocular pressure to the level at which the well-known pulsation phenomena occur in the retinal vessels. Baurmann's angiotonometer consists of a manometer-connected rubber balloon which is pressed against the globe. (cfr. Graefe's Arch. f. Ophth. 124:693, 1930).

The two instruments yield, on the human eye, consistently different values for the retinal arterial pressures. An investigation into the causes of the divergent results reveals possible sources of error inherent in both methods. (5 figures, 2 tables, 13 references)

Peter C. Kronfeld.

Sarwar, M. **Diagnostic contact lens.** Brit. J. Ophth. **38**:626-628, Oct., 1954.

The author reviews the pertinent literature on the subject especially the contributions of Koeppe, Goldmann, and Hruby. A new lens both for gonioscopy and fundoscopy with the slitlamp is presented. A binocular view is assured.

Orwyn H. Ellis.

Walker, W. Martin. **Corneal suturing forceps.** Brit. J. Ophth. **38**:629, Oct., 1954.

A corneal suturing forceps with a V-shaped prong to provide for passage of the needle is presented. It is used for corneal grafting and suturing, and in scleral resections. Orwyn H. Ellis.

6

OCULAR MOTILITY

Bjork, Ake. **Electromyographic studies on the coordination of antagonistic muscles in cases of abducens and facial palsy.** Brit. J. Ophth. **38**:605-615, Oct., 1954.

In total abducens palsy, relaxation of the sound antagonist does in fact take place, and during lateral movements of the gaze the electromyogram from the internal rectus of the paretic eye is the same as might be expected from the external rectus of the sound eye. In recording from the external rectus in a case of severe oculomotor palsy, the results were similar.

In attempts to close the eye in facial palsy, the pronounced and abrupt inhibition of the activity in the levator palpebrae muscle was demonstrated. It appears as though a similar mechanism is active in respect to the lower lid as well. The rapid increase of activity in the rectus superior, demonstrated in conjunction with Bell's phenomenon, seems to be matched by decreased activity represented by relaxation in the rectus inferior.

In experiments on eyes with normal motility, in which one eye is artificially compelled to assume different postures and perform different movements, the activity in the muscles does not appear to be affected by passive extensions.

Orwyn H. Ellis.

Crone, R. A. **Alternating hyperphoria.** Brit. J. Ophth. **38**:591-604, Oct., 1954.

Exceptions to Hering's law are not rare and monocular movements are seen when binocular vision is only slightly developed. There may be a disturbance of the monocular oculomotor reflexes in alternating hyperphoria.

Alternating hyperphoria may be explained by the hypothesis that the motor impulses from the lower nasal quadrant of the retina are deficient. There may be a relative unimportance of optical stimuli from above and from the side compared with those from the front and from below. When no paresis is present, the results of the prolonged occlusion test must be explained by a dissociated element in the hyperphoria. Orwyn H. Ellis.

Ten Doesschate, G., and Lansberg, M. P. **Time consumption in eye movements.** Ophthalmologica **128**:298-300, Nov., 1954.

The time consumption in eye movements, such as the aircraft pilot makes to look at his instrument panel, can be conveniently measured by recording the changes which the corneoretinal potential undergoes during ocular rotations. The electrodes are placed at both temples. (3 figures, 3 references)

Peter C. Kronfeld.

Foster, J., and Pemberton, E. C. **Hypertropia corrected by changes of the lateral rectus insertion.** Brit. J. Ophth. **38**:507-509, Aug., 1954.

The authors present summaries of 29 cases in which correction of a small vertical error was accomplished by elevation

or depression of a horizontal rectus muscle. Orwyn H. Ellis.

Malbrán, E., and Norbis, A. **Surgical correction of paralysis of the superior oblique muscle.** Arch. oftal. Buenos Aires **29**:455-466, Aug., 1954.

Five cases of unilateral superior oblique palsy are reported, in all of which the condition was congenital or acquired in infancy, and which for the most part exhibited an associated horizontal deviation. Operative correction was attempted by strengthening the affected muscle according to McLean's and McGuire's techniques; when necessary, additional surgery was performed on the internal and external rectus muscles. The results were invariably good. (13 figures, 22 references) A. Urrets-Zavalia, Jr.

Sarwar, M. **Extraconjunctival approach to the extraocular muscles.** Brit. J. Ophth. **38**:497-499, Aug., 1954.

When muscle surgery is to be done on patients who wear contact lenses, the author recommends that the incision be placed at the extreme ends of the palpebral fissure. In this way no conjunctival scar remains to interfere with the wearing of the lens. The procedure is only slightly more difficult than the usual approach. Orwyn H. Ellis.

Toselli, C., and Guzzinati, G. C. **The surgical treatment of isolated paralysis of the inferior oblique muscle.** Ann. di ottal. e clin. ocul. **80**:525-536, Dec., 1954.

Six cases of isolated paralysis of the inferior oblique muscle, three of which were associated with hyperfunction of the superior oblique, are presented. The results of resection and tucking of the paretic muscle and of intracapsular tenotomy of the hyperactive muscle are discussed. The combination of these procedures depends on the indication. The authors advise against weakening of the contralateral synergist (superior rectus) because of the resulting limitation of the field of fixation. (33 references) John J. Stern.

Urrets-Zavalia, Alberto. **Significance of congenital cyclovertical motor defects of the eyes.** Brit. J. Ophth. **39**:11-20, Jan., 1955.

Since vertical disturbances are rather commonly present in cases of horizontal strabismus, the observation of the position of the eyes in direct elevation and depression is of much diagnostic importance; these cases can be truly concomitant as regards the lateral deviation but may be quite incomitant in the magnitude of vertical deviation. When there is an overaction of one or both inferior oblique muscles, an elevation of the eye is found in adduction and when a paresis or underaction of the inferior oblique is present, then a depression of the eye is found in adduction; in either of these conditions the opposite deviation is seen when the eye is abducted.

The etiology of this combination of altered functions is not clearly understood but it is believed to be purely developmental and totally different in nature from the ordinary horizontal strabismus. If this is so, then a different classification of strabismus is indicated and the author recommends three categories: 1. strabismus of an ophthalmoplegic type, 2. strabismus of an anisesthetic type, and 3. primarily accommodative strabismus. (7 figures, 43 references) Morris Kaplan.

Walker, J. P. Spencer. **Congenital absence of inferior rectus and external rectus muscles.** Brit. J. Ophth. **38**:631, Oct., 1954.

The author reports the congenital absence of the inferior rectus and external rectus muscles in different patients. In each, the condition was found at surgery and in one the condition was greatly im-

proved with transplantation of a muscle.
Orwyn H. Ellis.

Weekers, R., and Daenen, P. **The surgical treatment of paralytic strabismus.** Bull. Société belge d'opht. **109**:1-177, 1955.

In this comparatively short monograph the fundamental concepts in the management of paralytic squint are presented in clear and concise form. Essential facts, concerning the anatomy, classification, and physiopathology of the ocular muscles in relation to future surgical repair and restoration of binocular function are discussed in successive chapters (2-5). The methods of examination are described in more detail in chapter 6. Different subjective and objective tests, as used at the Eye-Institute at Liége, are evaluated and the advantages in the use of the Hess-Lee coordimeter and in the tracing of fusion fields are enumerated. The surgical procedures favored by the authors are described in chapter 8. The excellent surgical results are summarized in chapter 9. An exact case history, pre- and postsurgical coordimeter charts and photographs, the variety of the cases published, and discussion and explanation of the indication for the successive steps in the various surgical procedures not only make excellent reading, but also give practical information and possible references for future handling of similar cases. To operate only on the paralyzed muscle is considered to be the greatest possible mistake and practically always is unsuccessful. In many cases of paralytic squint the ocular imbalance can be referred to an overaction of the homolateral antagonist, the heterolateral synergist, or both, and not to a weakness of the primarily paralyzed but later more or less recovered muscle. The choice of the proper procedures, the order of their performance should follow a certain basic principle but also should be adapted and carefully chosen for the individual case. Changes in surgical planning and changes and modifications in surgical techniques must be expected over the years. Operations on the oblique muscles, considered so difficult years ago, now have their evident and obvious indications. Recession of the inferior oblique muscle, subconjunctival myotomy of the inferior oblique, the intervaginal tenotomy and the tucking of the superior oblique are, at present, operations of choice. The extreme difficulties in the surgical management of diplopia in thyreotropic exophthalmos are illustrated. Diplopia in traumatic exophthalmos with and without limited motility of the eyeballs should be repaired by orbital restoration and without intervention on the extrinsic ocular muscles.

The authors are of the opinion that practically every case of paralytic squint, even an obstinate one, can be at least improved by surgical means. (185 figures, 3 tables, 199 references) A. R. Deutsch.

Westheimer, G. **A case of voluntary nystagmus.** Ophthalmologica **128**:300-303, Nov., 1954.

This case report concerns a 39-year-old man, free of any demonstrable neurologic or ocular disease, who at the age of 15 years learned—as a schoolboy prank—to elicit, by means of a strong convergence effort, a horizontal pendulum nystagmus lasting a few seconds. The amplitude of the nystagmus is about 5 degrees and the frequency 10 excursions per second. (1 figure, 6 references) Peter C. Kronfeld.

7

CONJUNCTIVA, CORNEA, SCLERA

Bagoczky, Louis. **New surgical methods for the correction of trachomatous lid deformities.** Ophthalmologica **128**:54-57, July, 1954.

To make up for the loss or shrinkage of conjunctiva which is the principal fac-

tor in trachomatous lid deformities, the author makes extensive use of mucous membrane grafts. Instead of typical peritomy he incises the bulbar conjunctiva 2 to 3 mm. from and concentrically with the limbus, and places an annular strip of buccal mucosa between the conjunctival wound lips. In his part of the world (Baja, Hungary), trachoma apparently is still a serious, deforming disease. (5 figures)

Peter C. Kronfeld.

Das, T., Sur, M. L., and Chaddah, M. R. **Corneal ulceration-sensitivity of bacteria to antibiotics.** Brit. J. Ophth. **39**:21-28, Jan., 1955.

In the Indian Punjab corneal ulcers are very common and respond only moderately to antibiotics. Cultures were made of 100 corneal ulcers, of 25 normal conjunctival sacs, 25 lacrimal washings, 25 external auditory canals and of 25 specimens of nasal secretion. Tests of sensitivity of these cultures to six antibiotics were carried out. The most common organism in the ulcers was found to be Staphylococcus pyogenes (31 percent) and the next most common was B. pyocyaneus (14 percent). The cultures of the normal conjunctiva and other sites revealed almost the identical organisms. In the sensitivity tests all the Gram-positive cocci were found to be quite sensitive to all the drugs except possibly sulfacetamide while the Gram-negative organisms, including B. pyocyaneus, were resistant to penicillin and aureomycin and somewhat sensitive to dihydrostreptomycin and terramycin. (3 tables, 7 references)

Morris Kaplan.

Mihalyhegyi, G. **The pathology of keratoconus. Further measurements of the curvature of the anterior segment.** Ophthalmologica **128**:203-212, Oct., 1954.

By means of accurate, photographically enlarged molds of living eyes, the author has been able to show that in keratoconus the anterior sclera participates in the cone formation. (4 figures, 10 references)

Peter C. Kronfeld.

Morate, F. H. **Conjunctival capillaroscopy.** Arch. Soc. oftal. hispano-am. **14**: 1217-1230, Oct., 1954.

Morate believes that slitlamp examination of the conjunctival vessels is unjustly neglected. The site of choice for study of the conjunctival vessels is the temporal portion of the globe. A narrow beam and a strong light are desirable. The color, the blood current, the vessel caliber of the normal and pathologic conjunctiva are described, and other data in 125 cases of various constitutional diseases are tabulated.

Ray K. Daily.

Pavkovic-Bugarski, G. **The role of aureomycin and terramycin in the treatment of trachoma.** Ophthalmologica **128**:180-196, Sept., 1954.

This report comes from the regional eye hospital and Anti-trachoma Center of Vojvodina (Jugoslavia) where trachoma has been endemic for over 150 years (cfr. Brit. J. Ophth. *38*:692, 1954). After a thorough review of the literature the author presents his own experiences with aureomycin and terramycin, both of which he uses in 1-percent ointment four to six times daily. In the second month the application of the ointment is combined with gentle massage of the conjunctiva. Of 170 cases treated in this manner, 95 were cured and 66 improved. The effect of the two antibiotics in trachoma is very similar, more definite than that of penicillin or sulfonamides, but not definite enough in the opinion of the author to justify the designation of specifically antitrachomatous drugs. It usually takes more than three months of treatment to reach a definitive result. Additional sulfonamide therapy by mouth tends to shorten the course of the disease. (48 references)

Peter C. Kronfeld.

Radnot, M., and Wallner, E. **Keratoconjunctivitis in a child.** Ophthalmologica **128**:355-358, Dec., 1954.

In a six-year-old girl lacrimal deficiency was associated with very marked salival deficiency, chronic glossitis and dryness of the skin. The case is classified as an ectodermal dysplasia. (1 figure, 5 references) Peter C. Kronfeld.

Sie-Boen-Lian. **Modification of the "bare sclera" pterygium operation.** Ophthalmologica **128**:58-60, July, 1954.

In Indonesia, the paper indicates, pterygium is as much of a problem as in the Southwest of the United States. The author and his colleagues treat recurrences by completely baring the affected portion of the sclera and by covering the defect with Thiersch flaps, buccal mucous membrane flaps, or free or pedicle conjunctival flaps. Even after such complicated surgical procedures the pterygium may recur. For these cases the author recommends burying and anchoring by sutures the head of the pterygium in a superficial, roughly rectangular scleral pocket. (1 figure, 2 references) Peter C. Kronfeld.

8

UVEA, SYMPATHETIC DISEASE, AQUEOUS

Agarwal, L. P., and Mehra, K. S. **The cysteine factor in endophthalmitis phakoanaphylactica.** Ophthalmologica **128**:351-354, Dec., 1954.

In 100 cases of mature senile cataract the authors found that cutaneous sensitivity to lenticular protein extract, prepared by the method of Burky and Woods, correlates well with cutaneous sensitivity to cysteine (.15 cc. of a 300 mg. percent aqueous solution of cysteine). Extracapsular cataract extractions performed on patients with high sensitivity to lens protein (or cysteine) were followed, in a large percentage of cases by marked iridocyclitis. The authors consider cysteine as the probable factor in lentogenic inflammations. (4 tables, 7 references) Peter C. Kronfeld.

Beverley, J. K. A., Beattie, C. P., and Fry, B. A. **Experimental toxoplasmosis of the uveal tract.** Brit. J. Ophth. **38**:489-496, Aug., 1954.

Toxoplasma was injected into the anterior chamber of rabbits which were then successfully treated with 4:4′-diaminodiphenylsulphone (D.D.S.). A secondary iritis, which developed later, was possibly the result of allergy. Cortisone abolished this secondary iritis and nearly complete cures were obtained. Early treatment was best. This treatment may be useful in the human infection. Orwyn H. Ellis.

Campo Balboa, J. A. **Intravenous injections of copper lactate in some cases of iridocyclitis.** Arch. Soc. oftal. hispano-am. **14**:1278-1285, Nov., 1954.

Intravenous injections of a 1-percent solution of copper lactate in 5 to 10 cc. doses, were found effective by the author in iridocyclitis which was probably caused by a virus and was resistant to other forms of therapy. Between three and 12 daily injections suffice for a cure. In the majority of cases the symptoms subside completely after the first or second injection. Three cases are reported. In two of unknown etiology the response was favorable and prompt. In one case, in which the uveitis followed an attack of Spanish recurrent fever, this drug was ineffective. (11 references) Ray K. Daily.

de Conciliis, Ugo. **A case of essential atrophy of the iris.** Gior. ital. oftal. **7**:456-464, Sept.-Oct., 1954.

A case of essential atrophy of the iris in a woman with pulmonary tuberculosis is described. The atrophic process in the iris was arrested during therapy with streptomycin and P.A.S., and this has led

the author to assume that the atrophy of the iris was secondary to the tuberculous process. (4 figures, 1 table, 56 references)
V. Tabone.

Huggert, A. **Uveitis in Hodgkin's disease.** Acta med. Scandinav. **151**:155-159, 1955.

The author reviewed four cases of his own and seven cases of uveitis associated with Hodgkin's disease which have been described in the literature. He concludes that uveal changes occurring in this disease should either cause doubts as to the correctness of the diagnosis of Hodgkin's disease or lead to a continued search for other possible reasons for the ocular symptoms. (23 references)
Irwin E. Gaynon.

Michaelson, I. C. **Disturbance of the choriocapillaris and retinal dehiscence.** Brit. J. Ophth. **38**:632-633, Oct., 1954.

A patient is presented who had a dehiscence of the retina and two small retinal holes. Numerous fine interlacing lines could be seen clearly in the dehiscence. These white lines may represent sclerosed vessels of the chorio-capillaris. Later the white lines displayed fine red central channels and small aneurysms could be seen.
Orwyn H. Ellis.

Strachman, Jerome. **Uveitis associated with chicken pox.** J. Pediat. **46**:327-328, March, 1955.

Unilateral uveitis, following chicken pox in a six-year-old child is reported. There was circumcorneal congestion, dustlike uveal precipitates, edema of the retina, and a dilated fixed pupil. The response to local therapy, intramuscular cortisone and penicillin was good. This is the third case of uveitis reported which occurred as a complication of chicken pox. (1 figure, 5 references)
Irwin E. Gaynon.

Wagener, Henry P. **Toxoplasmic chorioretinitis in the adult.** Am. J. M. Sc. **229**:205-216, Feb., 1955.

The author reviews present concepts of toxoplasmic chorioretinitis in the adult. For a number of years, toxoplasmosis has been a recognized cause of chorioretinitis in infants and a suspected cause in adults. Recently, parasites resembling toxoplasma have been found in the retina during histopathologic examination of eyes with focal chorioretinal lesions acquired in adult life. In one such case, the parasites were proved to be living members of the genus toxoplasma by culture and animal passage. These findings would appear to establish acquired toxoplasmic chorioretinitis in adults as a clinical disease entity. However, definite statements with regard to the frequency of its occurrence and the relative importance of toxoplasmosis as a cause of chorioretinitis in adults are not possible as yet. Whether or not toxoplasmosis can cause primary anterior uveitis has not been determined and no definite criteria have been generally agreed upon as necessary for the clinical diagnosis of toxoplasmosis in an individual case of chorioretinitis. Treatment in presumptive or proved cases of toxoplasmosis is generally unsatisfactory. Sulfonamides in combination with pyrimethamine (daraprim) are recommended. (14 references) William C. Caccamise.

9

GLAUCOMA AND OCULAR TENSION

Brand, Imre. **The incidence of vascular disease in glaucoma patients.** Ophthalmologica **128**:281-287, Nov., 1954.

In a population of 119 glaucoma patients, 12 out of 44 deaths were the result of cerebral hemorrhage. This is twice as high an incidence of apoplexy as in non-glaucomatous aged hypertensive individuals. Among the glaucoma patients dying from apoplexy, the incidence of absolute

glaucoma was "extremely high." The author interprets these findings as evidence of a parallelism between ocular and cerebral vascular disease in glaucoma. (1 table, 45 references)

Peter C. Kronfeld.

Caselli, Francesco. **The results of experimental iridencleisis.** Gior. ital. oftal. 7:440-455, Sept.-Oct., 1954.

The author describes the results of histologic studies at the site of iridencleisis performed on ten rabbits. He found that very soon the incarcerated iris becomes invaded by fibrous tissue and that no filtration is possible through this type of tissue. The favorable results of iridencleisis, both on the eye operated upon and the other one, are therefore due to vasomotor changes brought about by the operation. The author also expresses the view that this operation is the one of choice for reducing ocular tension and for increasing the permeability of the blood-aqueous barrier. (4 figures, 1 graph, 2 tables, 19 references) V. Tabone.

Dobree, J. H. **Effect of raised ocular tension on the episcleral vessels.** Brit. J. Ophth. 38:500-506, Aug., 1954.

When the tension is elevated in chronic glaucoma one usually finds a dilatation of the anterior ciliary arteries, especially the perforating branches. The episcleral veins change little but the others gradually recede with the lowering of the tension. Dilated veins are particularly prominent in absolute primary glaucoma. This seems to be a compensatory change, for the occurrence of dilated veins implies that much of the blood destined for the interior of the globe has been short-circuited into the superficial veins through anastomotic channels in the vicinity of the limbus. Orwyn H. Ellis.

Dusseldorp, M., and Piantoni, G. H. **Repeated trephine operation for glaucoma.** Arch. oftal. Buenos Aires 29:437-439, Aug., 1954.

Blockage of the trephine hole following an Elliott operation usually results from the filling up of the wound by proliferation of scar tissue and leads to a recurrence of increased tension. The authors consider that the iridosclerectomy should then be repeated at 6 o'clock as the most favorable site. Such a procedure was performed in 10 cases, in 9 of which the intraocular pressure could thus be adequately controlled. It must be pointed out, however, that the filtering bleb is then liable to catch on the lower lid margin and become more conspicous, and that an iridectomy at this place is very likely to cause dazzling or diplopia or both. (1 figure) A. Urrets-Zavalia, Jr.

McBain, Earle H. **Diagnosis and treatment of glaucoma.** California Med. 81: 231-234, Sept., 1954.

Tonography in the diagnosis of doubtful cases of chronic simple glaucoma gives a good indication of the status of the disease in a given eye and may be helpful. The most useful miotic is still pilocarpine. DEP produces undesirable side effects. Diamox is a carbonic anhydrase inhibitor that is effective orally. In many cases it produces at least a temporary lowering of tension in glaucomatous eyes. Cyclodiathermy has had a recent increase in use but the long-term results have been disappointing. The importance of early operation in narrow-angle glaucoma is apparent. The wound should be tightly sutured after iridectomy.

Orwyn H. Ellis.

Rohrschneider, W., and Kuechle, H. J. **The standard error in tonometry.** Ophthalmologica 128:369-379, Dec., 1954.

The variations between tonometric readings repeated on rabbit and human eyes at 3-minute intervals were deter-

mined; 8 to 15 readings were taken on each eye. One two-man team of examiners made all the measurements, using a standard Schiøtz tonometer and the 7.5 gram weight. Only local anesthesia was used. Particularly in the rabbit, the examiners were very careful to obtain uniform position of the animal's head during the reading. As was to be expected, some animals "learned" faster than others, that is, submitted to tonometry more readily and with less squeezing.

For each eye, that is for each set of 8 to 15 tonometric readings, the authors calculated the mean and the standard deviation. For 60 rabbit eyes the standard deviation varied from ± 0.2 to ± 1.2 with a mean of ± 0.75 tonometric scale units. 99.55 percent of all individual readings fell within the range of ± 2 scale units of the respective mean which also represents approximately ± 3 standard deviations. By careful selection of "well-behaved" animals for experimental studies of the ocular tension, one may be able to reduce the error slightly.

The standard error in tonometry of human eyes was considerably smaller. The mean standard deviation for 50 human eyes was ± 0.37 scale units and the range within which most of the individual readings fell, was ± 1.0 scale units relative to the mean. (3 tables, 23 references)

Peter C. Kronfeld.

Weekers, R., Prijot, E., and Gustin, J. **The measurement of the resistance to aqueous outflow. Part six: the mode of action of adrenaline in chronic glaucoma.** Ophthalmologica **128**:213-217, Oct., 1954.

Weekers and associates recently reported the tension-lowering effect of an especially prepared adrenaline solution (Levorenone, Henrioul, Brit. J. Ophth. Dec., 1954). One instillation of this solution lowers the ocular tension in chronic glaucomas for two or three days. This tension-lowering effect lasts very much longer than the local vasoconstriction and the mydriasis.

The paper under review concerns itself with a tonographic analysis of the action of this adrenaline solution in chronic glaucomas. Tonographic measurements were made on 21 patients with chronic glaucoma, first without medication and then again 24 to 48 hours after the instillation of the drug. When the initial (premedication) tension was below 35, the topical administration of adrenaline caused an average drop in tension of 8 mm. without any change in the resistance to outflow. The tension-lowering effect in these cases was probably due to a reduction in aqueous flow, that is aqueous production.

In cases with initial tensions above 35, adrenaline caused an average drop of 15 mm. associated with an apparent improvement in the tonographic measurements. Weekers and associates are hesitant to accept this as evidence of lowered outflow resistance since tonography at the initial high tension level entails a considerably greater possibility of experimental error than the tonography at the normal, post-medication, level. Thus their tentative conclusion is that adrenaline lowers the ocular tension by reducing aqueous production. (1 table, 3 references)

Peter C. Kronfeld.

10

CRYSTALLINE LENS

Barth, Jost. **The crystalline lens in myotonic dystrophy.** Ophthalmologica **128**: 288-297, Nov., 1954.

In the study of the relationship between myotonic dystrophy and cataract, the examination of whole families is very revealing. While the lens opacities are often not quite as typical as described by Vogt, and borderline and transitional forms are quite common, their occurrence in members of myotonic families often permits their rec-

ognition as myotonic lens opacities. (8 figures, 9 references)

Peter C. Kronfeld.

Parry, T. G. Wynne. **Modification in intraocular acrylic lens surgery.** Brit J. Ophth. **38**:616-618, Oct., 1954.

A modification of Ridley's procedure is presented in which the acrylic lens is held in place with fine tantalum wire after intracapsular cataract extraction. After an initial reaction the eye cleared and vision was excellent. Orwyn H. Ellis.

Rodrigues Barrios, R., and Echagüe Vera, J. V. **Complications of cataract surgery.** Arch. Soc. oftal. hispano-am. **14**: 1286-1295, Nov., 1954.

The complications of 453 operations for cataract, done during the last three years, are analyzed. The surgical complications were as follows: loss of vitreous 7.5 percent; loss before delivery of the lens, 3.3 percent; and after delivery of the lens 4.1 percent. In one of these patients retinal detachment developed, in the others, deformity and displacement of the pupil with a slight reduction in vision. The capsule ruptured in 11.5 percent of cases. After rupture of the capsule, an attempt was made to grasp the lens at the equator and extract the capsule with the nucleus. If this failed, the sutures were tied and an attempt was made to extract the capsular rests; this complication was of no consequence. In one patient a transient glaucoma developed; it was controlled with miotics. Most of the ruptured capsules occurred with hypermature cataracts. There was one expulsive hemorrhage. The postoperative complications were as follows: iris prolapse 1.7 percent, incarceration of the iris 1.5 percent, severe ocular infection 0.4 percent, sympathetic ophthalmia 0.4 percent, and retinal detachment 0.6 percent. There were three cases of retinal detachment, in one of which vitreous had been lost, one occurred in an eye with high myopia, and one followed a blow on the head; surgical therapy was unsuccessful. In 20 patients the anterior chamber was obliterated between the fifth and eighth day, as a result of choroidal detachment. The choroid became reattached spontaneously and no glaucoma developed subsequently. Glaucoma developed in 2.4 percent of the patients and epithelization of the anterior chamber in 0.4 percent. Two patients developed epithelial cysts in the anterior chamber. The cysts were extirpated and the eyes were treated successfully with radium. Bullous keratitis occurred once when the vitreous was found to be in contact with the cornea. Intraocular hemorrhage was noted in 7.7 percent of the eyes, one patient had hemorrhage into the vitreous, and another blood staining of the cornea because of slow absorption of a large hyphema; in the others the hemorrhage was of no consequence. (7 tables)

Ray K. Daily.

11

RETINA AND VITREOUS

Appelmans, M., and Lamotte, R. **The coagulability of the blood in cases of thrombosis of the central retinal vein.** Ophthalmologica **129**:1-22, 1955.

Careful studies of the coagulability of the blood in 15 cases of thrombosis of the central retinal vein revealed no demonstrable anomaly. Ten of the patients were treated with anticoagulants. To the authors, it does not seem as though this form of treatment materially improves the visual prognosis in thrombosis of the central retinal vein. (2 figures, 3 tables, 22 references) Peter C. Kronfeld.

Bedrossian, Robert H. **Neuroretinitis following measles.** J. Pediat. **46**:329-331, March, 1955.

Only nine cases of neuroretinitis following measles have been reported, and

none in English. This case occurred in a six-year-old girl with typical measles. She complained of pain on moving her eye and sudden loss of vision. The vision was reduced to light perception, the pupils were enlarged and did not react well. The nerve head was hyperemic, the vessels tortuous, and the retina markedly edematous. The patient was given ACTH but there was very little response to therapy until the third week, when trypsin was given intramuscularly. Final visual acuity was 6/9 and her fields were contracted to 9 degrees. (1 figure, 9 references)

Irwin E. Gaynon.

Brehme, Th. **Etiology, pathogenesis, and prophylaxis of retrolental fibroplasia.** Schweiz. med. Wchnschr. **85**:302-305, March 26, 1955.

Brehme discusses the main facts that have emerged from the study of retrolental fibroplasia. It is clear that exposure to too great an oxygen concentration for too long is the primary factor in the pathogenesis of the retinopathy of prematurity. It is, however, not yet clear by what process the excess oxygen leads to retinal vasoconstriction. The following explanations are given: 1. Growth is characterized by glycolytic processes. 2. For the retina, a high anaerobic glycolysis is the physiologic internal environment. 3. Since oxygen inhibits glycolysis, the exposure of the premature infant to excessive oxygen concentration brings about constriction of the arterial vessels in the unripe or inadequately vascularized fetal retina in the sense of a counter-regulation against hyperoxia. 4. Because the strangulation of the afferent vessels leads to an inadequate supply of nutrients, further progress of the developmental pattern of the retina is interrupted. 5. After return to normal atmospheric conditions, the original plan of organization of the development of the retina is not resumed but is replaced by primitive undifferentiated vascularization and formation of connective tissue.

Retrolental fibroplasia can be prevented by a drastic reduction of oxygen in the incubator. (5 references)

F. H. Haessler.

Fischer, Franz. **Retinopathy and diabetes mellitus.** Arch. f. Ophth. **155**:567-573, 1954.

400 diabetics without retinopathy were clinically compared with 220 patients with retinopathy. In the following list of percentile magnitudes the values for the second group are given in parentheses: Age: under 20: 4.7 (0.5), 21-45: 16, 2 (5.9), 46-75: 75 (85), over 76: 3.5 (8.6).—Blood-pressure: systolic values: 110-140: 40 (15.9), 145-160: 24 (17.7), 165-190: 24 (38.6), 195-230: 11 (28.1). Diastolic values: above 100: 12 (19).—Albuminuria: 17 (55). Kidney function disturbed: 1.3 (20.9).—Arteriosclerosis: 28.7 (55.4).—Constitutional factors: High-pressure diabetes: 72 (82.7), low-pressure diabetes: 28 (17.2).—Heredity: 2.25 (26.3).—Duration of the disease: up to 4 years: 62 (23.18), up to 10 years: 11.7 (10.4), up to 16 years: 11.7 (31.8), up to 30 years: 14.5 (34.5).—Onset: before 21st year of age: 6 (3.18), before 40: 16.2 (13.1), before 60: 55, (66.6), after 60: 22.7 (17.2).—In 51.5 percent of the former group, retinal changes consisted in narrowing of the arteries, dilatation of the veins, and Marcus Gunn phenomenon. In the second group, three types of retinal changes were seen: retinal hemorrhages, retinal exudates, and retinal proliferation. The retinopathies more often occurred in patients over 46 years of age, affected both sexes about equally, combined more often with high blood pressure, albuminuria, functional disturbances of the kidneys, and arteriosclerosis. Retinal exudates and proliferations seemed to represent inherent diabetic factors while the retinal

hemorrhages might just be facilitated by the diabetic condition. (15 references)

Ernst Schmerl.

François, J., Vanderstraeten, M., and Neetens, A. **The retinal circulation during oxygen therapy. The pathogenesis of retrolental fibroplasia.** Ophthalmologica **128**: 73-98, Aug., 1954.

The purpose of this study is to demonstrate the effects of intensive oxygen therapy upon tissues in general and on the retina in particular. These effects can be observed in patients with severe emphysema who are receiving intensive oxygen therapy. In such cases the present writers as well as previous observers have found: 1. marked dilation and tortuosity of the retinal veins, 2. constriction and tortuosity of the retinal arterioles, 3. slight edema of the macular region, 4. in very severe cases requiring prolonged oxygen therapy, punctate hemorrhages in the periphery and flame-shaped hemorrhages along the veins.

Constriction of peripheral arteries under the influence of oxygen therapy has been demonstrated in a number of other situations. If it occurs in the patient with emphysema and tissue anoxia, a condition of prestasis develops in the capillaries and veins, giving rise to edema and passage of red cells into the retinal tissue.

The retinal manifestations of oxygen therapy in patients with severe emphysema are directly comparable to retrolental fibroplasia, that is, the retinal changes occurring in premature infants during intensive oxygen therapy. Again, according to the present writers, a spastic constriction of the retinal arterioles under the influence of oxygen therapy is the principal pathogenetic factor. This arteriolar vasconstriction may be overshadowed by the dilation and tortuosity of the veins which represents the first recognizable manifestation of retrolental fibroplasia. Among 200 premature infants treated at the University of Gand (Belgium) with oxygen concentrations not exceeding 40 percent during the first 2 hours in the incubator and not exceeding 25 percent at any time thereafter, not a single case of retrolental fibroplasia occurred. With regard to the prevention of the disease the authors' recommendations concerning oxygen therapy are very similar to the conclusions of the retrolental fibroplasia symposium at the last (1954) meeting of the American Academy of Ophthalmology and Otolaryngology. (7 figures, 165 references)

Peter C. Kronfeld.

Huerkamp, B., Leidig, L., and Klomp, G. **Concomitant symptoms in retinal detachment.** Arch. f. Ophth. **155**:556-566, 1954.

1,500 case histories were reviewed. In about 14 percent of all cases retinal detachment had occurred in both eyes. In onesided detachment, the following conditions had been found: myopia 44 percent, no other ocular involvement 28 percent, rupture of the ora serrata 13 percent, injuries to the eye 12 percent, corneal scars 5 percent, aphakia 5 percent, and retinal folds 0.5 percent. More men than women were afflicted (3:2). Detachment in both eyes occurred more often in people under 40 years of age, detachment in one eye more often in people over 40 years. Marfan's syndrome had been seen in three cases. The findings do not permit one to draw any conclusions with respect to the pathogenesis of retinal detachment. (2 figures, 6 tables, 4 references)

Ernst Schmerl.

Iinuma, I. **Clinical observation of Oguchi's disease. Part II.** Acta Soc. Ophth. Japan. **59**:238-242, March, 1955.

In Oguchi's disease, Iinuma studied the influence of the state of adaptation of one eye upon the dark adaptation of the

other. In the first experiment the light adaptation prior to the dark adaptation was only induced in one eye. Then later the course of dark adaptation was accelerated more in this eye than when the second eye had also been adapted to light coincidentally with the first eye. In the second experiment, the second eye was repeatedly exposed to light during the dark adaptation of the first eye. The dark adaptation in the first eye retrogressed to a certain extent each time. The completion of the dark adaption in the first eye, therefore the appearance of Mizuo's phenomenon, was considerably protracted.

The author considers that a contraction and dilatation of blood capillaries in the retina and choroid is induced, respectively, by light and dark adaptation. These changes occur not only directly but also consensually. Thus the state of adaptation in one eye is influenced by that in the second eye. (*2* figures, 11 references)

Yukihiko Mitsui.

Parry, H. B. **Degenerations of the dog retina.** Brit. J. Ophth. **39**:*29-36*, Jan., 1955.

This is the seventh in a series of studies on the degenerations of the dog retina and deals specifically with a central nonprogressive degeneration due to an anomaly of the ganglion cells and their axons. In a family of cocker spaniels there were eight cases of this degeneration of the central retina of which four were examined clinically and one pathologically. These lesions were probably congenital. The dogs have a central scotoma from infancy due to degeneration of the optic nerve fibers and of the ganglion cell layers of the central part of the fundus. In the peripheral parts of the retina these same layers seemed entirely normal. Three of four dogs also had suture cataracts of the fetal nucleus of the lens. The presence of the suture cataracts points to some disturbance in the developing eye during late intrauterine life. The etiology and nature of this change remains obscure. (*2* figures, 12 references)

Morris Kaplan.

Pereira, R. F., Aiçaguer, O., and Galván, C. **Treatment of thrombosis of the retinal veins by trypsin injections.** Arch. oftal. Buenos Aires **29**:431-434, Aug., 1954.

The fibrinolytic effect of parenterally administered trypsin has been reported as being of definite value in the treatment of cases of obstruction of the central retinal vein or its branches. Two cases of this condition are reported in which the drug, given intravenously in daily doses of 10 mg., proved of no assistance whatever. (*2* references)

A. Urrets-Zavalia, Jr.

Piper, H. F. **Cavernous hemangioma of the retina.** Ophthalmologica **128**:99-106, Aug., 1954.

The ophthalmoscopic picture described here is that of a mulberry-like, well circumscribed, unilateral tumor of the retina, not associated with any other anomaly of the retinal vessels. The condition was present in an 11-year-old girl and a four-year-old boy. The girl showed a mild inactive form of pulmonary tuberculosis; the boy was normal except for his eye condition. Both children were, apparently, observed for a short time only. Dilimiting treatment of unstated type was being contemplated. (*2* figures, 28 references)

Peter C. Kronfeld.

Poos, Fr. **The pathogenesis of retinal detachment.** Arch. f. Ophth. **155**: 530-555, 1954.

This is the first paper of Volume 155, No. 6 and it might be mentioned that the cover of this number reads: "100 Jahre Albrecht von Graefes Archiv für Ophthalmologie!" The paper itself mainly presents theoretical considerations about the pathogenesis of retinal detachment. In its summary the pathogenetic role of

cystoid degeneration of the retina is emphasized. Mechanical forces exercized by anatomic changes may play a major part in the development of retinal holes and detachment. A second paper is promised in which these phenomena as well as the process of retinal reattachment will be discussed in detail. (49 references)

Ernst Schmerl.

Serpell, Geoffrey. **Polysaccharide granules in association with developing retinal vessels and with retrolental fibroplasia.** Brit. J. Ophth. **38**:460-471, Aug., 1954.

Large numbers of periodic acid Schiff-positive granules were found in the inner retinal layers in intimate association with the areas of mesenchymal cell proliferation in the early stage of retrolental fibroplasia. The granules were found to be strictly intraretinal; where capillary buds grow out from the retina into the vitreous, whether canalized or not, the granules were found only in the adjacent retina and not in the intravitreal outgrowths. The granules were identified histochemically as glycogen. PAS-positive granules were usually found in diffuse distribution and in no case were they found in front of the anterior limit of the capillary bed. When present, they were always found in the inner retinal layers, which are nourished by retinal capillaries. In full-term infants no retina showed an increase in mesenchymal cells and there was a complete absence of PAS-positive granules from the inner retinal layers. In kittens in which new vessel formation in the retina and vitreous has been induced by treatment with oxygen, PAS-positive granules were found in the retina in proliferating cell masses but not in the vitreous. The density of the granules was greater in proliferating cell masses than in newly-formed canalized capillaries. A co-existence of mesenchymal cell increase and PAS-positive granules at the anterior limit of the retinal capillary bed was found in 23 of 25 stillborn premature infants. Similar observations were made on the 16, 18, and 19-week-old fetuses.

Orwyn H. Ellis.

Simkova, M., and Zahn, K. **An attempt to treat hypertensive retinopathy with hydergin.** Ophthalmologica **128**:218-231, Oct., 1954.

This report concerns a group of twenty patients with cardiovascular hypertensive disease including retinopathy, which were maintained as out-patients, on hydergin medication for an average period of one year. Most of the patients received the drug in the form of intramuscular injections (0.3 mg. each), the frequency of which was gradually reduced from once daily to once a week at a rate depending upon the patient's response to the drug. The patients remained under careful medical and ophthalmological observation, the latter including angioscotometry and measurements of retinal vascular pressures. The majority of the patients showed objective and subjective improvement; some of them were able to go back to work. Retinopathy of grade III or IV (Keith-Wagener), present at the inception of the treatment, regressed to grade II in 14 of the 20 cases. The authors consider the result of the prolonged hydergin medication excellent in 11 of their cases, satisfactory in four cases and questionable or unsatisfactory in the rest. (2 tables, 31 references) Peter C. Kronfeld.

Ward, B. A. **Ocular histology in premature infants with reference to retrolental fibroplasia.** Brit. J. Ophth. **38**:445-459, Aug., 1954.

In the review of the literature it was pointed out that no fetal eyes showed retrolental changes such as vitreous hemorrhages or vascular changes. Loose retinal coaptation, retinal edema and hemorrhages are usual findings in premature infants. Ward found that 1. the

retina was avascular at from 8 to 12 weeks; 2. early vascularization was present at the posterior pole at 12 to 13 weeks; and that 3. vessels and vaso-formative tissue, which had reached the equator by 19 to 28 weeks, were ⅓ of the way to the ora by 25 to 35 weeks, and ⅔ of the way by 29 to 32 weeks, and had reached the ora by 29 to 35 weeks. Vascular growth and particularly any unusual degree of proliferation is slowed down after birth. Flat retinal preparations showed an open, actively-branching, embryonic type of capillary net and an adult vascular pattern.

No special relationship was established between the vascular changes and eye size. The vascular changes were associated with an incompleted retinal circulation and the degree of incompleteness is variable and not directly related to the degree of angioblastic activity. Retinal congestion was a prominent feature in ten cases. Retinal hemorrhages were of slight degree only, except in two cases, in which they were being invaded by endothelial cells. Congestion of the uveal tract was frequent. There was an unusually marked degree of angioblastic activity, most commonly in front of the equator.

Thickening of the nerve fiber layer of the retina, due to endothelial and to a lesser extent to mesenchymal cell proliferation is the earliest microscopic change seen in the disease. No definite relationship is established to hemorrhages, retinal or choroidal congestion, retinal edema, defects in the internal limiting membrane, or other structural abnormalities. Orwyn H. Ellis.

Zahn, K., and Simkova, M. **The effect of priscoline upon the retinal circulation.** Ophthalmologica **129**:44-52, Jan., 1955.

Twenty individuals with well-stabilized cardiovascular hypertensive disease were given one dose of 10 mg. of priscoline subcutaneously. For a period of about two hours the pulse rate and brachial and retinal vascular pressures were closely watched and the angioscotomas were plotted several times.

The systemic and retinal vascular pressures showed no significant changes under priscoline. The area of the angioscotomas decreased sharply in about half of the patients and increased at about the same rate in the other half. Only the reduction in the size of the angioscotomas may be regarded as a beneficial effect upon retinal circulation. From the general clinical standpoint, the patients belonging to the two groups did not show any perceptible difference. Before priscoline is used therapeutically in a given case, the response of the angioscotoma to a test dose of the drug should be determined. (4 tables, 28 references) Peter C. Kronfeld.

12

OPTIC NERVE AND CHIASM

Jamieson, K. G. **A mechanism of primary oculomotor nerve injury.** Australian & New Zealand J. Surg. **24**:236-238, Feb. 1955.

Four cases of primary oculomotor nerve lesion are presented which occurred after a blow on the head in the anterior temporal region without damage to the superior orbital fissure. The most likely process of nerve damage is a stretch injury in continuity from rotation or displacement. Recovery is to be expected. The lesion is particularly likely to be confused with extradural hemorrhage.

Ronald Lowe.

Jayle, G. E., and Croisy, A. **Unilateral subacute edematous optic neuritis.** Gior. ital. oftal. **7**:377-393, Sept.-Oct., 1954.

Six cases of unilateral subacute optic neuritis are described in detail, and the significance of such findings as edema of the disc, the visual fields, and very slight diminution of the visual acuity are

discussed. The prognosis is favourable, and the disturbance is probably the result of a virus infection. (25 figures)

V. Tabone.

13

NEURO-OPHTHALMOLOGY

Alajmo, Arnaldo. **Contribution to the study of "negative accommodation" of Le Grand.** Gior. ital. oftal. 7:414-428, Sept.-Oct., 1954.

The author gives an extensive and interesting review of the literature on the double innervation of the iris, with particular reference to the phenomenon of so-called negative accommodation. He describes experiments which confirm the double innervation of the iris but do not show the existence of negative accommodation, except perhaps as an anomoly in a few subjects. (15 references)

V. Tabone.

Arkin, W., and Hryniewska, H. **Insulin shock therapy of retrobulbar neuritis.** Ophthalmologica **128**:107-114, Aug., 1954.

In a series of 30 cases of retrobulbar neuritis, mild insulin shock therapy (30 to 40 units intravenously, daily for four to six days) was remarkably effective in reducing or abolishing the central scotoma and in improving visual acuity. The authors consider most of their cases as early forms of multiple sclerosis. (1 table, 6 references) Peter C. Kronfeld.

Boschi, Gaetano. **Observations on nystagmus.** Riv. oto-neuro-oftal. **28**:441-445, Sept.-Oct., 1953.

The author discusses various aspects of nystagmus, starting with the fundamental phenomenon, namely incoordination. He points out the intimate rapport between the labyrinth, the cerebellum, and the eye.

Theodore Bisland.

Cueppers, C. **Continuous registration of the direct and consensual pupillary reaction.** Arch. f. Ophth. **155**:588-616, 1954.

The author discusses the requirements for a well-defined retinal stimulation and a continuous registration of the pupillary reaction. The latter procedure was achieved by photoelectric measurements of the varying quantities of pupillomotor-inactive infrared light reflected from the contracting and dilating iris diaphragm. Retinal stimulation was also provided by the recording instrument and special consideration was given to the intensity of the stimulus, its color, duration, and size of its optical image. The rather complicated apparatus needed for this kind of stimulation and recording was built by the optical company E. Leitz, Wetzlar. With its help the author obtained the following results: continuous registration of the pupillary diameter, increase of the contraction and dilatation of the pupil with the increase in duration and intensity of the foveal stimulation, shorter reflex period, and accelerated pupillary contraction with increase in intensity of the stimulus. For discussion and technical details the original paper should be consulted. (23 figures, 18 references)

Ernst Schmerl.

Karstien, Hans-Dietrich. **Accommodation and convergence following stimulation of the vestibular apparatus.** Arch. f. Ophth. **155**:574-587, 1954.

Studies of other authors had shown that by stimulation of the vestibular apparatus autonomic reflexes could be elicited. In the present investigation the problem whether accommodation and convergence were affected by rotatory or caloric stimulation of the vestibular organ was studied. More than 60 persons were examined and three reactions were observed. The distances for the nearpoints of accommodation and convergence either increased or decreased or did not change at all. The changes occurred immediately after stimu-

lation and lasted for not more than 20 minutes. (2 figures, 6 table, 25 references)
Ernst Schmerl.

Loewenstein, Otto. **Alternating contraction anisocoria: a pupillary syndrome of the anterior midbrain.** Arch. Neurol. & Psychiat. **72**:742-757, Dec., 1954.

The author describes a new syndrome, revealed by his technique of pupillography. It consists of an inequality of the pupils when under the influence of a pupilloconstrictor stimulus, such as light. The pupil of the stimulated eye always contracts more extensively than the consensually reacting pupil of the opposite side. Three forms are described: the unilateral, the bilateral, and the complicated (by additional pupillary pathology). The condition was found in lesions of the anterior midbrain, of which 35 percent were infections probably transmitted by the cerebrospinal fluid, 11 percent multiple sclerosis, 17 percent the result of abnormality and 14 percent heredodegenerative conditions. In a painstakingly detailed discussion on localization the author concludes that the lesion is probably located in the posterior commissure and in one (unilateral syndrome) or both (bilateral syndrome) brachia of the superior colliculi. He suggests that the disturbance involves crossed fibers of both the first and second neuron of the light reflex and is probably situated beneath the superior cistern. (9 figures, 2 tables, 10 references)
Harry Horwich.

Poulsen, Poul Aagaard. **Zoster ophthalmicus.** Acta Med. Scandinav. **151**:131-134, 1955.

Herpes zoster ophthalmicus is very rare in the first three years of life. This case occurred in a 15-months old boy; the lesion was unilateral, with the typical eruptions, keratitis, corneal hypesthesia, and iridocylitis. The juvenile types seem to be characterized by a lack of burning sensations and neuralgia. (2 figures, 19 references)
Irwin E. Gaynon.

Remky, Hans. **Ophthalmoplegic migraine.** Arch. f. Ophth. **155**:518-524, 1954.

The author studied the question whether in ophthalmoplegic migraine symptoms are produced by pressure upon the third nerve and the posterior cerebral artery. Examination of three groups of patients seemed to confirm this assumption. The first group consisted of 103 patients with migraine without ocular manifestations. These patients showed signs either of angiospastic or angio-atonic conditions combined with miosis, flicker scotoma and normal permeability of the blood vessels in the former, and mydriasis and increased permeability in the latter condition. The second group consisted of seven patients with ophthalmoplegic migraine. The symptoms in these subjects occur in two phases: 1. retinal vascular spasms, miosis, and flicker-scotoma, and 2. vascular hypotonia, mydriasis, increased vascular permeability and paresis. In the third group four patients are described in whom the symptoms of ophthalmoplegic migraine were caused by the pressure of expanding tumors or aneurysms. (11 references)
Ernst Schmerl.

Schechter, F. R., Lipsius, E. I., and Rasansky, H. N. **Retrobulbar neuritis: a complication of infectious mononucleosis.** Am. J. Dis. Child. **89**:58-61, Jan., 1955.

Four weeks after the onset of illness, when the heterophile agglutination was returning to normal, the patient developed blurred vision in the right eye. Visual fields were normal with a 1-mm. white test object, but a relative scotoma for red of 3 to 4 degrees was demonstrable with a 3 mm. test object. The disturbance disappeared after one year. (30 references)
Irwin E. Gaynon.

Thiel, J. H. **Chronic progressive ophthalmoplegia with extraocular extension**

(ocular myopathy). Folia Psychiat., Neurol. et Neurosurg. Neerl. **57**:554-563, Dec., 1954.

After a brief, but up-to-date, historical review of this entity, five cases are presented. The first three occurred in four out of six siblings whose parents and grandparents may have been affected. The fourth case is one in which electromyography was done, and in the fifth, a biopsy was performed. Considering the first siblings as only one case, the author added a number of cases seen earlier in patients whom he reexamined for comparison. He could then review a series of eight cases. In this series he found that seven had definite extraocular extension, the most noteworthy being facial diplegia and a nasal monotonous voice. Perhaps this unusually high incidence is due to the long duration of the disease in these instances. (6 figures, 27 references)

Harry Horwich.

Winkelman, J. E. **Marcus Gunn syndrome.** Ophthalmologica **129**:63-66, Jan., 1955.

A case of left-sided Marcus Gunn syndrome showed two unusual features. The best and practically normal position of the ptotic left upper lid was obtained when the patient looked at himself in the mirror, using the left eye for fixation. Shutting the right eye was associated with some elevation of the left upper lid. An acceptable cosmetic correction was obtained by a recession of the left inferior rectus muscle, a resection of the left superior rectus, and a Guyton-Friedenwald (tantalum suture) sling operation. (3 figures)

Peter C. Kronfeld.

14

EYEBALL, ORBIT, SINUSES

Arouh, J., and Silberstein, M. **Incomplete syndrome of the orbital apex.** Arch. oftal. Buenos Aires **29**:441-445, Aug., 1954.

The case of a 33-year-old man is presented, in whom, following a severe thoracic compression, diplopia when looking up and to the left, a slight proptosis of the left eye, and a transient, supraorbital pain developed in the course of two months. In addition, some degree of palpebral edema and congestion of the conjunctival vessels were seen. Fundus examination disclosed papilledema and engorgement of the retinal veins on the affected left eye, as well as a few minute exudates and hemorrhages scattered all over the region of the posterior pole. Vision was 20/20 and 20/25 in the right and left eye, respectively. Neurologic and roentgenologic examinations were negative. Penicillin administration resulted in complete recovery. The condition was ascribed to a circumscribed periostitis at the orbital apex. (6 figures, 13 references)

A. Urrets-Zavalia, Jr.

Arruga, H. **A plastic orbital implant.** Arch. Soc. oftal. hispano-am. **14**:1271-1277, Nov., 1954.

Arruga modified the implant which he reported in 1952 by making it with two round pegs, like the one used by Moura Brazil. The two pegs eliminate the rotation of the prosthesis, which is not eliminated with one peg. The implant is made of plastic, and the pegs are 1 mm. thick and 6 to 8 mm. long, of rustless metal. The implants are made 14, 16, and 18 mm. in diameter. There are four openings in the implant for the rectus muscles. The conjunctiva of the eyeball is dissected backwards, the muscles are isolated, and are fixed by sutures and cut close to the globe. The eyeball is enucleated and the implant inserted in place. The rectus muscles are overlapped, and the suture tied in the manner of a mattress suture. The vertical muscles are united in the same manner. The conjunctiva and Tenon's capsule are closed by a continuous suture,

burying the pegs. At the end of six or eight days the pegs perforate the conjunctiva spontaneously, without leaving an open wound at their base, which happens if they are not buried. A temporary prosthesis may be introduced a few days after the wound is healed. The chief advantage of this prosthesis is rapid healing of the wound, and absence of secretion. The prosthesis should be very small; just large enough for its edges not to show when the patient looks to the side. This implant was used in *27* patients, without expulsion of implant, or significant secretion. (6 figures)

Ray K. Daily.

Handousa, Ahmed. **Localized intraorbital amyloid disease.** Brit. J. Ophth. **38**:510-511, Aug., 1954.

A case of a slowly progressive proptosis is presented. The intraorbital mass could not be freed surgically; biopsy showed "amyloid tumor." A septic focus was considered to be the cause.

Orwyn H. Ellis.

15

EYELIDS, LACRIMAL APPARATUS

Beard, Crowell. **Upper lid repair.** Tr. Am. Acad. Ophth. **58**:*586-589*, July-Aug., 1954.

The author discusses the problems in repair of the upper lid and divides the lesions into three groups: congenital defects, traumatic defects, and defects caused by the removal of neoplasms. He describes the procedures used. (12 references)

Theodore M. Shapira.

Dekking, H. M. **A new ptosis operation.** Ophthalmologica **128**:*365-369*, Dec., 1954.

The author describes a slight modification of Machek's ptosis operation. The important steps are illustrated by drawings. (9 figures)

Peter C. Kronfeld.

Gurling, K. J., Bruce-Pearson, R. S., and Pond, M. H. **Sjørgren's syndrome treated with ACTH.** Brit. J. Ophth. **38**:619-625, Oct., 1954.

Six patients with Sjørgren's syndrome of decreased lacrimation, dry mouth, and rheumatoid arthritis were treated with ACTH and three were given cortisone as well. No increase in parotid or lacimal secretion resulted even though biopsy showed some normal gland tissue.

Patients with arthritis were relieved as in uncomplicated rheumatoid arthritis, which suggests that the arthritic lesions differed in etiology. The increase in urinary 17-ketosteroid excretion, and the gain in weight demonstrated that the ACTH provided adequate adrenocortical stimulation.

ACTH reduced the size of parotid swellings as long as treatment was continued. Symptomatic treatment is more effective in the relief of other symptoms.

Orwyn H. Ellis.

Iliff, Charles E. **A simplified dacryocystorhinostomy.** Tr. Am. Acad. Ophth. **58**:590-592, July-Aug., 1954.

The author describes his procedure using the Stryker saw and cathether in this simplified method. (12 references)

Theodore M. Shapira.

Theodore, Frederick H. **Differentiation and treatment of eczemas of the eyelids.** Tr. Am. Acad. Ophth. **58**:*708-723*, Sept.-Oct., 1954.

Successful management depends upon differentiation of the major causes, as treatment varies accordingly. He divides eczemas into three groups: 1. allergic eczematous dermatitis, due to contact allergy, in which the basic treatment is elimination of the allergens; 2. infectious eczematoid staphylococcal dermatitis secondary to infection of the eyelid, the most common cause of chronic eczema encountered by ophthalmologists, in which inten-

sive treatment with anti-infective medicaments, staphylococcus toxoid and vaccine is indicated; and 3. certain generalized dermatoses such as atopic dermatitis, seborrhea and psoriasis, in which the nonspecific eczema of the eyelid that occurs with diagnostic lesions elsewhere on the skin requires gentle stage-by-stage symptomatic treatment. (6 figures, 40 references)

Theodore M. Shapira.

16

TUMORS

Handousa, A. **Multiple myelomatosis with proptosis.** Brit. J. Ophth. **39**:41-43, Jan., 1955.

Multiple myelomata can possibly occur primarily in any of the bones and when occurring in the orbit proptosis results. A 50-year-old woman is described who had rapidly developing proptosis of the right eye with no manifestations of disturbance elsewhere. Laboratory tests, particularly the finding of Bence-Jones proteose in the urine, were suggestive of multiple myelomatosis and the skull X-ray as well as biopsy of the orbit confirmed the diagnosis. (4 figures, 2 references)

Morris Kaplan.

17

INJURIES

Tomar, V. P. S. **Intraocular magnetic air-gun shot.** Brit. J. Ophth. **39**:50-51, Jan., 1955.

A five-year-old boy was shot in the eye with an air-gun. The injury resulted in severe intraocular destruction. Since air-gun pellets are usually of lead, it was decided to enucleate the eye. In the postoperative examination of the eye, the pellet was found to be of steel. Careful determination of the possible magnetic attraction of any intraocular air-gun pellet is suggested. (2 figures, 18 references)

Morris Kaplan.

18

SYSTEMIC DISEASE AND PARASITES

Bech, Knud. **A case of polycythemia vera with early eye symptoms.** Ophthalmologica **128**:345-350, Dec., 1954.

The first subjective manifestation of Vaquez's disease in a 47-year-old man was episodic blurring of vision. The ophthalmologic examination revealed congestion of the entire face including the conjunctiva, obstruction of a branch of one central vein, and extensive retinal hemorrhages. The eye manifestations led to the recognition of the systemic disease. (1 figure, 19 references)

Peter C. Kronfeld.

Clifton, F., and Greer, C. H. **Ocular changes in acute systemic lupus erythematosus.** Brit. J. Ophth. **39**:1-10, Jan., 1955.

Two cases of acute, severe, fatal systemic lupus erythematosus with clinical and histologic studies of the eyes are described. The first case occurred in a 24-year-old diabetic woman who developed acute, severe lupus which responded briefly to frequent doses of ACTH but after a few months she died. There was no ocular discomfort but in the fundus one saw congestion of the vessels with circumpapillary edema, superficial hemorrhage near the vessels, and several superficial cotton-wool exudates adjacent to the vessels. In postmortem microscopic examination of the eye, marked edema of the fiber layer of the retina with scattered aggregations of cytoid bodies was found. The layer of rods and cones was almost completely transformed into a granular subretinal fluid.

The second case occurred in an 18-year-old girl who died in a few days. She noted blurring of vision. There were many more of the cytoid bodies grouped around the disc which showed circumpapillary edema. The veins were congested and

there were a few superficial hemorrhages. In section the retina was found to be thick and edematous with large aggregations of cytoid bodies within the nerve fiber layer. The outer plexiform layer showed large accumulations of albuminous transudate and the rods and cones had undergone similar granular degeneration.

These retinal changes seem to occur frequently in lupus erythematosus. It is assumed that a cardinal factor in the development of the cytoid bodies is a toxic damage to the capillary endothelium and extravasation of plasma and red cells into the nerve fiber layer. (4 figures, 17 references) Morris Kaplan.

Dew, H. R. **Primary cerebral hydatid disease.** Australian & New Zealand J. Surg. **24**:161-171, Feb., 1955.

Ten cases are described. The average age of the patients was ten years. Symptoms are those of simple space occupying lesions with increased intracranial pressure. Visual field studies are most important and the optic radiations are frequently involved. The Casoni test is unreliable. Adult life is rarely reached with an intact cyst. In "hydatid countries" any large lesion of the cerebrum in youth should be suspect. Ronald Lowe.

Lloyd, Ivor. **Unusual case of myasthenia gravis.** Brit. J. Ophth. **39**:48-49, Jan., 1955.

A man, 55 years of age, had noted progressive weakness of lids and eye muscles for 20 years. He had constant diplopia, ptosis, and almost complete ophthalmoplegia. He had had to stop driving and had given up much of his business activities since his condition had continued to progress. He was given several conjunctival injections of prostigmine and atropine with almost instantaneous cessation of all the symptoms that had persisted for 20 years. He has since used prostigmine tablets with apparently an almost complete cure and a return to normal. Morris Kaplan.

Montanari, M., and Chinaglia, V. **Congenital toxoplasmosis; report of a case.** Riv. oto-neuro-oftal. **28**:404-431, Sept.-Oct., 1953.

The case of a three-months-old infant is described. He had hydrocephalus apparently due to a meningo-encephalitis and bilateral ocular lesions in the fundus of each eye, involving the macular region of the right eye, the juxta-papillary region of the left, and also the periphery of both eyes. The blood and spinal fluid reacted positively to the Sabin-Feldman dye test. The blood of the mother showed a negative reaction to this test. The lack of cerebral calcifications was attributed to the short duration of the infection. (5 figures) Theodore Bisland.

Nichele, G., and Cati, P. **Importance of ophthalmoscopic observations in tuberculous meningitis.** Boll. d'ocul. **33**:816-832, Dec., 1954.

Detailed observation of 213 children with tuberculous meningitis, 65 with meningitis and miliary tuberculosis and 23 with pulmonary miliary tuberculosis is described. Two tables review the results: of 89 patients between 3 and 6 years of age, 53 were cured; of 90 between 7 and 12 years of age, 55 recovered. In almost 29 percent of the patients there were no ophthalmoscopic signs; of these children, 36 died, 51 were cured. In almost 27 percent, choroidal tubercles were found, 33 times in 213 children with meningitis; 28 times in 65 patients with meningitis and miliary tuberculosis, and almost always (20 times among 23) in acute miliary dissemination. Fifty-two of the patients with choroidal tubercles died, 29 survived. In more than 24 percent, hyperemia of the disc and slight edema were encountered;

of these, 49 died and 33 survived. Definite edema of the discs was seen in almost 9 percent; 15 of these patients died, 12 survived. Severe papilledema was found in more than 9 percent; 19 of these patients died, 9 survived. Neuropapillitis was diagnosed in one child who survived. Partial or complete atrophy of the optic nerves was found in 42 patients; of these 22 died and 20 survived. The appearance of new tubercles during treatment was generally preceded by a relapse. The evolution of the papillary lesions is parallel to the clinical course of the disease. It does not seem that they must be attributed to a toxic action of the streptomycin but rather to inflammatory or compressive processes in the opticochiasmal region. (24 references) K. W. Ascher.

Thomas, C., Cordier, J., and Algan, B. **Ocular changes in the disease of Ehlers-Danlos.** Arch. d'opht. **14**:691-697, 1954.

The authors note that hyperelasticity of the skin is not the sole pathologic change in the skin in the disease of Ehlers and Danlos. There is also a fragility of the skin resulting in frequent tears. Wounds cicatrize slowly but tend to lead to vegetations and cheloids. Other signs in the syndrome include relaxation of the joints, molluscoid pseudotumors, hematomas, muscular hypotony, arterial hypotension, prolonged coagulation time, and hypercalcemia. Participation of the eye in the syndrome is through involvement of the connective and elastic tissues. The authors note ptosis, ease of turning the upper lid, strabismus, blue scleras, keratoconus, subluxation of the lens, degeneration of the lamina vitrea of the choroid with angioid streaks, and choroidal hemorrhages. They describe the close relationship of the syndrome to the syndromes of Marfan and pseudoxanthoma elasticum.

P. Thygeson.

Unger, Lothar. **Visual impairment after loss of blood.** Klin. Monatsbl. f. Augenh. **126**:41-50, 1955.

A 41-year-old woman had severe vaginal hemorrhages during the second month of pregnancy. The pregnancy had to be interrupted and a few days later the patient noted gradual loss of vision which progressed until she was completely blind. Both nerveheads were elevated, the retinas were edematous, and macular hemorrhages were present. With blood transfusions and antibiotic treatment the patient regained some vision. (1 figure, 1 table, 27 references)

Frederick C. Blodi.

Venturi, G. **Ocular manifestations of epidemic parotitis.** Boll. d'ocul. **33**:807-815, Dec., 1954.

In five patients with epidemic parotitis, conjunctival, corneal and scleral complications were observed. The author assumed that the mumps virus was effective either by toxic action or by real invasion of the tissues of the eye. Microscopic examinations of the conjunctival discharge and of conjunctival scrapings, bacteriologic examinations and attempts to isolate the virus, inoculation into rabbit eyes and interference tests all gave negative results. Venturi thinks therefore that the virus had disappeared from the tissues at the time when the tests were performed. A rare complication of mumps is described: bilateral superficial punctate keratitis. (14 references)

K. W. Ascher.

19

CONGENITAL DEFORMITIES, HEREDITY

Cambiaso, R. H. **Coloboma of the iris and talipes varoequinus.** Arch. oftal. Buenos Aires **29**:403-410, July, 1954.

An 11-year-old, clubfooted boy exhibited bilateral and symmetrical inferoexternal coloboma of the iris. The eyes were otherwise normal, except for a

moderate hyperopic astigmatism; corrected vision amounted to 0.8 in the right eye and to 0.6 in the left one. The family history was noncontributory. This case, which indubitably resulted from a germinal disturbance or from an environmental influence affecting the embryo at an early stage, reminds one of those, frequently described in literature, where malformations of the extremities are seen to occur in association with a cleft-lip or a cleft-palate. (2 figures, 27 references)

A. Urrets-Zavalia, Jr.

Colombi, Carlo. **Retinitis pigmentosa and congenital malformation of the eye.** Rassegna ital. d'ottal. **23**:417-428, Sept.-Oct., 1954.

Numerous congenital malformations are presented, including retinitis pigmentosa, keratoconus and keratoglobus, anomalies of incomplete closure of the embryonal fissure, remnants of the embryonal vessels, malformations of lens and parasitic cysts of the vitreous. The author reports two cases of retinitis pigmentosa associated with keratoconus and is inclined to agree with Casini, who considers these two defects to be the result of a single dystrophic process in the embryonic proencephalon. (1 figure, 56 references)

Eugene M. Blake.

de Gennaro, Giuseppe. **Is the glioma of the retina hereditary?** Rassegna ital. d'ottal. **23**:375-392, Sept.-Oct., 1954.

At times the glioma of the retina appears as a hereditary tumor of a recessive type, and at other times as a dominant. In the latter case the growth may assume a familial character and the descendents are affected in about one-half of the cases. Recessiveness has become rare. Many are convinced of the hypothesis of Franceschetti of the origin of the glioma, namely that it is a mutation which at times demonstrates a tendency to a recessive or dominant pattern of heredity. Since systematic family studies show a sporadic character in the great majority of cases of glioma, the data suggest either a mutation or a recessive character. (9 tables, 82 references) Eugene M. Blake.

Gregory, Irene D. R. **Congenital ectodermal dysplasia.** Brit. J. Ophth. **39**:44-47, Jan., 1955.

Congenital ectodermal dysplasia is fortunately rare and presents widespread lesions, some of which involve mesodermal tissue. Scarcity of hair, abnormal or absent teeth and nails, absence of mucous glands of the nose resulting in rhinitis, dry skin, skeletal abnormalities involving the bridge of the nose and underdevelopment of the lower jaw, and ocular irregularities are among the manifestations of the disease. In London's schools for partially sighted three cases were found in which most of these signs and symptoms were noted. Two of the children had congenital cataract while the other had large patches of chorioretinitic atrophy and normal lenses. (4 figures, 3 references) Morris Kaplan.

Guzzinati, G. C. **Clinical manifestations of congenital ocular lesions possibly attributable to German measles and to epidemic hepatitis.** Boll. d'ocul. **33**:833-841, Dec., 1954.

The teratogenic role of virus diseases in pregnant women is illustrated by two unusual cases, one of pigmentary retinosis of the right eye and complete cataract of the left eye, attributable to maternal measles during pregnancy; the other of parapapillary choroidal coloboma of one eye in a child born of a mother who, during the third month of pregnancy, most probably was the victim of epidemic hepatitis. (54 references)

K. W. Ascher.

Jaeger, Wolfgang. **Dominant hereditary**

optic atrophy. Arch. f. Ophth. **155**:457-484, 1954.

The author studied four families in which a special type of optic atrophy was found. In one of the families four generations were examined and 35 members of the family were found to be affected. The author separates the entity of dominant hereditary optic atrophy from Leber's optic atrophy, from optic atrophy with nystagmus, from congenital optic atrophy and from Behr's complicated optic atrophy. Heredity is dominant, consanguinity has no part in the condition, men and women are equally affected, the papillae show normal temporal pallor, nystagmus is not present, vision may be normal or lowered to 1/10 of the normal vision, the blind spot is sometimes enlarged, peripheral contraction of the visual field may or may not be present, and disturbance of color vision is pronounced. The onset of the condition probably occurs in early childhood. The condition is usually stationary or slowly progressive. There are no other symptoms. (3 figures, 2 tables, 37 references)

Ernst Schmerl.

Poppi, M., and Wencelblat, D. **Report on a hitherto undescribed cephalic malformation.** Arch. oftal. Buenos Aires **29**: 375-381, July, 1954.

The case of a new-born child is described, in which, owing to a complete aplasia of the osseous scaffolding of the orbits, the eyeballs occupied an abnormally lateral and most protruding position. They could be palpated almost completely through the overlying skin. The cornea—much flattened, imperfectly clear and of a somewhat irregular surface—was exposed through a very small cutaneous opening; its epithelium was in direct continuity with that of the skin. The iris was well formed and the pupil central and miotic. The lens was present and transparent, but the fundus could not be adequately explored. The lower lid was present, although rudimentary, while the upper one was reduced to two small cutaneous outbuds, through one of which the secretory duct of the lacrimal gland reached what was left of the conjunctival sac. The motility of the globes was preserved to some extent. The external orbital wall was lacking, so that the orbital cavity communicated freely with the temporal fossa. The child was otherwise normal and progressed satisfactorily. The family history was noncontributory.

The condition might be assessed as one ranging midway between those of ablepharon and cryptophthalmia. However, if the bony defect is fully taken into account, the whole picture seems to represent an extreme form of that malformation recently described under the name of primitive aplasia of the orbital margin. (5 figures) A. Urrets-Zavalia, Jr.

20

HYGIENE, SOCIOLOGY, EDUCATION, AND HISTORY

Cohn, Ludwig. **Substitute functions of the blind and the deaf and blind.** Brit J. Ophth. **38**:680-684, Nov., 1954.

Generally the loss of vision excites the greatest sympathy and yet there are very few tasks which the blind cannot do. Those who are both deaf and blind all consider their loss of hearing the greater handicap. The introduction of Braille in 1829 brought to the blind the printed word including pictures, maps and music. The sense of touch quickly becomes developed in the sightless and no person seems to be too old or too awkward to benefit by it. The sense of hearing is the second most important substitute function and one which brings the whole world into the mind of the blind. A third substitute is the sense of smell which, although of minor importance, does serve as a good guide when the blind walk without a companion.

The deaf and blind are considerably more handicapped than the blind and fortunately are rarer. Communication between these people and their environment is very difficult but the Lorm system of touch alphabet read with the back of the hand helps considerably. They develop an additional sense which is difficult to describe; a sense of orientation, of simply feeling that some object is near. In some subjects this can be developed to a great extent both by direct training and by natural growth. Morris Kaplan.

Pallarés, J. **The ophthalmological service of Hospital Antiquaille at Lyon.** Arch. Soc. oftal. hispano-am. **14**:1302-1339, Nov., 1954.

The author spent 16 days visiting Paufique's service in Lyon, and describes in detail the plan of the ophthalmologic service, and the technique of the major surgical procedures used by Paufique. (2 figures) Ray K. Daily.

Rintelen, F. **Legal and compensation aspects of ocular injuries.** Ophthalmologica **128**:326-343, Nov., 1954.

At the request of the Swiss Ophthalmological Society the author has outlined the duties and functions of the ophthalmologist in connection with the appraisal of permanent visual loss arising from occupational diseases or injuries. In the relationship between patient and insurance company, the ophthalmologist should maintain an entirely neutral position and try to convey to the patient a good understanding of the provisions of the law or of the insurance policy. On the one hand, the ophthalmologist must see to it that the patient receives all the care and compensation to which he is entitled; on the other hand, the ophthalmologist must protect the insurance company against unjustified claims.

A detailed history taken at the time of the first contact between patient and ophthalmologist is of the greatest importance. The principal question is: was there an external injurious incident, sudden, out of the ordinary and unintended, that could have played the part of either the direct cause or of a precipitating factor in the ocular pathologic process?

Rintelen deals in detail with the situations in which the insurance company has the right to request the patient to submit to reconstructive ocular surgery. The role of trauma in the causation of retinal detachment, herpetic keratitis and serpentic ulcer is discussed specifically. Finally, Rintelen presents in six tables his method of appraising visual efficiency, taking into consideration primarily reduction in central visual acuity and construction of the visual field. Additional compensation on the basis of "ophthalmological" considerations is granted in any of the following situations: a patient engaged in work requiring good visual acuity, marked disfigurement, persistent epiphora, insufficient lid closure, diplopia, photophobia, quadrantic or hemianopic field defects and aphakia. (6 tables, 8 references) Peter C. Kronfeld.

NEWS ITEMS

Edited by Donald J. Lyle, M.D.
601 Union Trust Building, Cincinnati 2

News items should reach the editor by the 12th of the month but, to receive adequate publicity, notices of postgraduate courses, meetings, and so forth should be received at least three months before the date of occurrence.

Deaths

Dr. Joseph I. Pascal, New York, New York, April 22, 1955.

Announcements

Orthoptic examinations

The annual examination of orthoptic technicians by the American Orthoptic Council will be conducted in August and October, 1955.

The written examination will be nonassembled and will take place on Thursday, August 25th, in certain offices and will be proctored by designated ophthalmologists.

The oral and practical examinations will be on Saturday, October 8th, in Chicago just preceding the meeting of the American Academy of Ophthalmology and Otolaryngology.

Application for examination will be received by the office of the secretary of the American Orthoptic Council, Dr. Frank D. Costenbader, 1605 22nd Street, N.W., Washington 8, D.C., and must be accompanied by the examination fee of $30.00. Applications will not be accepted after July 1, 1955.

Graduate medical training in neurology and ophthalmology

Graduate medical training grants of $126,000 have been awarded to the Graduate School of Medicine, University of Pennsylvania, for a two-year period by the National Institute of Neurological Diseases and Blindness to initiate a unique program of training teachers and investigators in the fields of neurology and ophthalmology. Dr. Julius H. Comroe, Jr., professor of physiology and pharmacology, will be the program director.

The new course, to begin in the fall of 1955, will be the first of its kind in this country. It will be designed for neurologists and ophthalmologists who have decided to enter or continue a full-time academic career in teaching and research in these specialties. Prospective candidates must either be certified by the American Board of Neurology or the American Board of Ophthalmology or must have all or most of the requirements for board certification.

Preference will be given to men who have been selected by their own medical school faculties for advanced training, with the understanding that after the academic year at the Graduate School of Medicine they will return to their own departments to do full-time teaching and investigative work as a career.

Probably not more than five neurologists and five ophthalmologists will be accepted during the first year; it is hoped that the majority of these will be able to obtain partial fellowship support during the training period. One or two internists or surgeons may be accepted during the first year in order to determine the effectiveness of the new program in training medical teachers and investigators in general.

An important part of this new course will be instruction in the art and technique of teaching. This will be accomplished largely by practical work. Initially, the group technique will be utilized in which each member of a small group is in turn the lecturer while the remainder of the group serves as a critical audience.

Each lecture will be recorded so that the lecturer will have the benefit of both the playback and audience reaction (see *Journal Medical Education*, **29**:39, 1954). Recordings will be kept and compared with later performances in order to gauge progress.

Later, the "students" will be given active teaching responsibilities, under supervision. Since teaching involves more than lecturing to large groups, there will also be considerable practice in conference, seminar, and ward-round types of teaching. No attempt will be made to achieve uniformity in teaching; the emphasis will be upon improvement in those teaching techniques best suited to the personal attributes of each physician.

In addition, attention will be paid to the use of visual aids, the proper design of examinations, and appropriate faculty-student relationships. Special seminars on medical writing and library utilization will be given.

The men will also be given broad training in the basic medical sciences of physiology, pharmacology, biochemistry, anatomy, pathology, and microbiology, with particular emphasis on their relation to clinical problems.

Another feature of the course will be a training program designed to provide a good scientific background for medical research. The faculty realizes full well that it cannot create investigators by didactic courses. However, it believes that it can provide an opportunity for advanced learning that would be very difficult to obtain through existing means. Among the new courses to be created especially for this group are:

1. Mathematics for physicians engaged in medical research.
2. Statistics and the design of experiments.

3. Recent advances in electronics, chemistry, and physics.
4. Techniques of investigation and their critical analysis.
5. Seminars on critical evaluation of medical literature.
6. Philosophy of research.

Since many of the trainees may eventually become departmental chairmen, special seminars will also be given on medical administration (including budgeting, personnel selection, hospital administration, and voluntary health plans).

These courses will be given by outstanding teachers, clinicians, scientists, editors, and educators, many of whom will be from universities outside of the Philadelphia area.

Although it is anticipated that "students" in this course will already be well qualified clinically, courses in the present program of the Graduate School of Medicine may be taken by the group as elective courses. In addition, an opportunity will be offered for investigative work. The course work, coupled with research, will be acceptable as credit for the degree of Doctor of Science (Med.).

Address inquiries to:
J. H. Comroe, Jr., M.D.
Graduate School of Medicine
University of Pennsylvania
Philadelphia 4, Pennsylvania

Miscellaneous

Gill Hospital congress

The Gill Memorial Eye, Ear, Nose, and Throat Hospital has completed its 28th annual spring congress in ophthalmology and otolaryngology. There was a total attendance of 350 doctors and their wives from all over the United States and Canada. The next congress will be held April 2 through April 7, 1956.

Personals

Dr. Ludwig von Sallmann, professor of ophthalmology at the College of Physicians and Surgeons, Columbia University, and attending ophthalmologist at the New York Presbyterian Hospital, will join the National Institute of Neurological Diseases and Blindness, Public Health Service, as visiting scientist, on August 1, 1955, in order to direct and expand its eye research program at the Clinical Center. Dr. von Sallmann will continue his studies there on ocular neurophysiology and ocular pharmacology and is now actively recruiting a research staff for these and other investigations.

The University of Louisville conferred an honorary Doctor of Science degree on Dr. Frederick H. Verhoeff, consulting chief of ophthalmology at the Massachusetts Eye and Ear Infirmary and professor emeritus of ophthalmic research at the Harvard Medical School, on the occasion of its commencement exercises, June 5th.

Dr. Verhoeff, a native son of Louisville and doyen of ophthalmic pathologists, also spoke at the annual postgraduate seminar of the University of Louisville School of Medicine, on June 6th.

Dr. Theodore Fischer-Galati of Lawrence, Massachusetts, announces his imminent departure for the study of ocular leprosy at the leprosy hospital of Dr. Albert Schweitzer at Lambaréné on a grant from an anonymous donor. He was recently elected corresponding member of the Société d' Ophtalmologie de Paris.

Stanford University School of Medicine, San Francisco, California, has announced the appointment of Dr. Dohrmann K. Pischel as head of the Division of Ophthalmology. Dr. Pischel, who has been connected with Stanford Medical School since 1928, received the A.B. degree from the University of California in 1918 and the M.D. degree from Stanford University Medical School in 1923.

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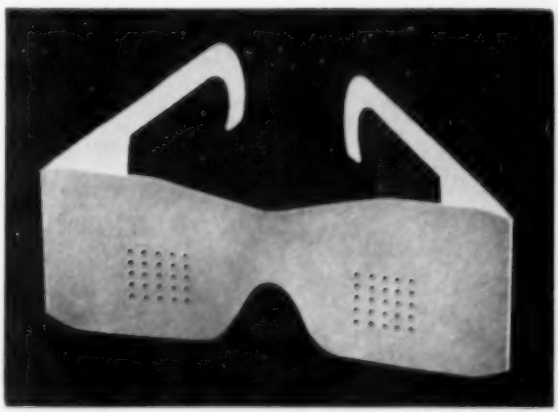

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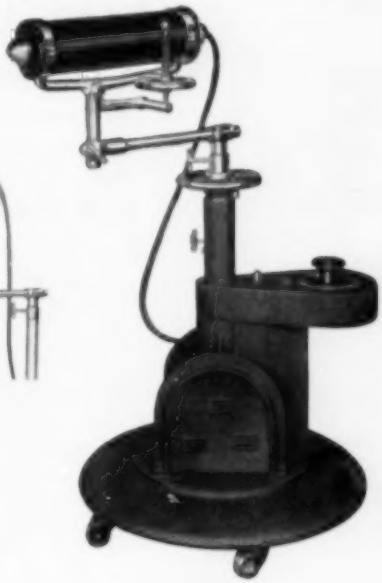

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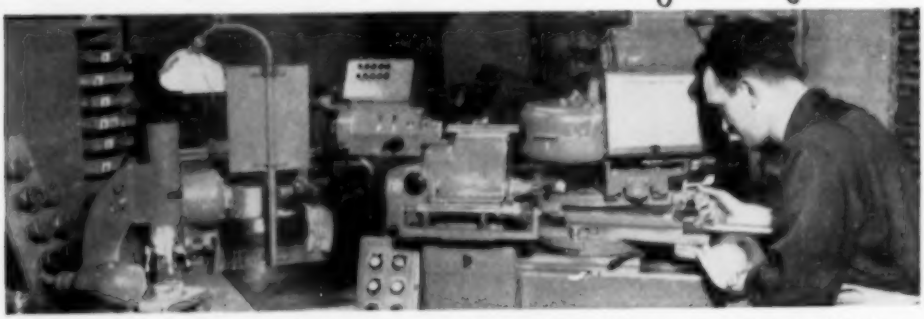

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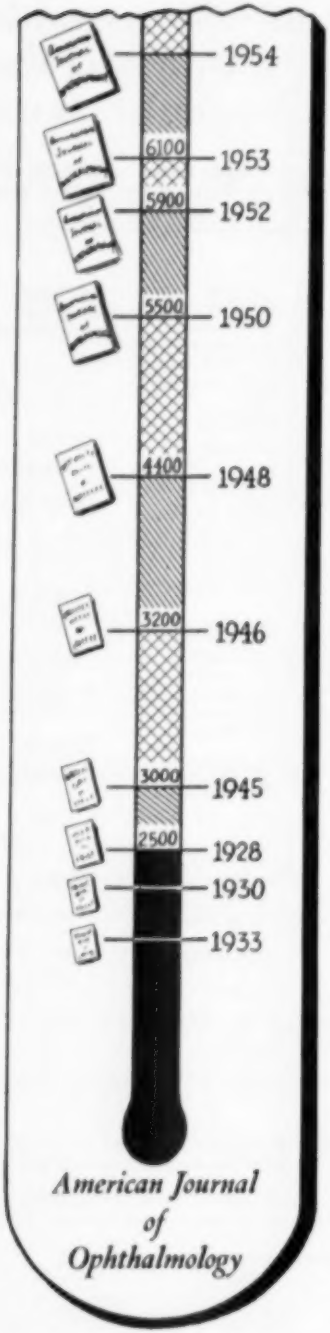
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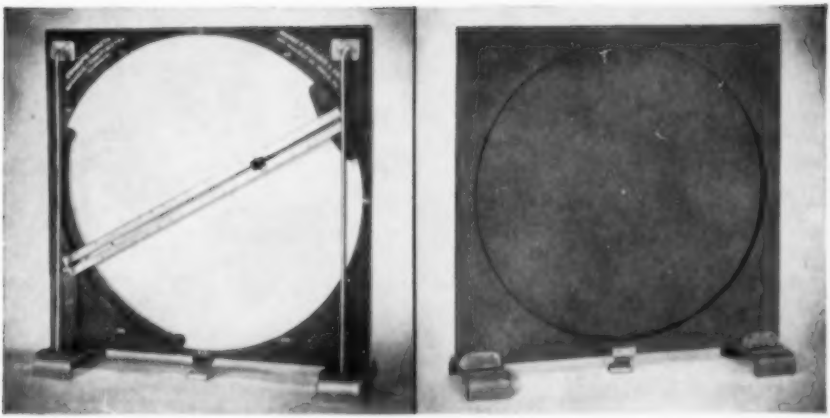

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